

MAR 15 1924

Motorship

New York

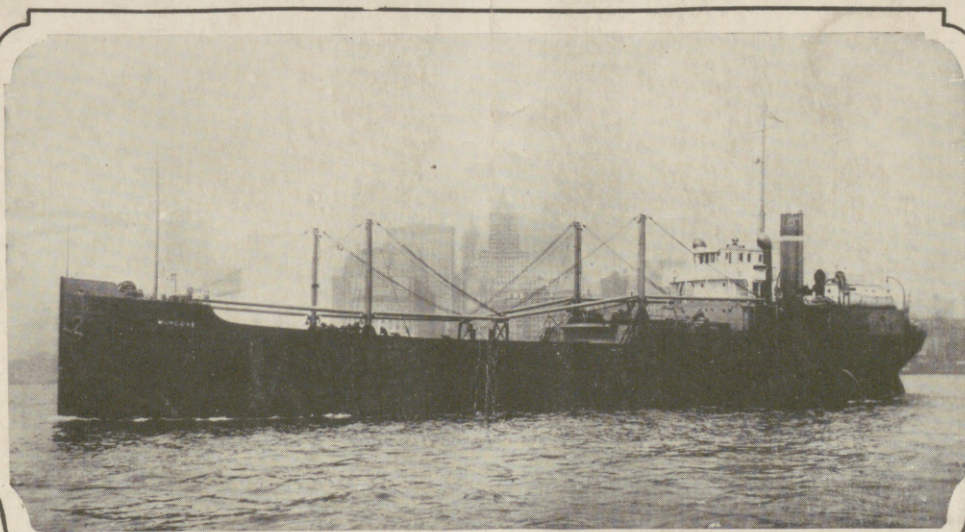
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MARCH, 1924

**MARINE DIESEL ENGINES
FOR ALL CLASSES OF SHIPS**



M. S. MUNCOVE

Length 353'6", Width 43'6", Depth 27'6"
Draft 23'6", Deadweight Capacity 4125 Tons
Single Screw, 1200 I.H.P., Oil Engine

**MCINTOSH & SEYMOUR
CORPORATION**

MAIN OFFICE AND WORKS - AUBURN, N.Y.

Volume IX, No. 3

Price, 25 Cents

EXCLUSIVE technical and non-technical articles on design, construction and operation of oil-engines and motorships by the world's foremost writers on marine engineering.

Motorship

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Vol. IX

New York, U. S. A., March, 1924
(Cable Address—Freemote, New York)

No. 3

Forced Draft on Motorship Nets Big Operating Gains

DRIVING a Diesel engine at a continuous and permanent overload of 17% under sea-going conditions is a performance surely without parallel in the annals of motorshipping. In view of the well-known sensitiveness of internal-combustion engines to long-continued overloads, the results realized on Wilhelm Wilhelmsen's twin-screw motorship *TIRADENTES* have a high technical significance and important commercial implications as well. For one thing, if a Diesel-driven ship can maintain absolutely reliable operation under conditions of forcing so severe as those obtaining on the *TIRADENTES*, the doubts of those who still persist in regarding the modern motorship as experimental begin to look a little absurd. Rating power-plant boilers at from 400 to 600% capacity is common everyday practice, whereas 100% has been regarded as amply sufficient for internal combustion engines of all kinds. Owing to the higher capital investment represented by ships equipped with internal-combustion propel-

Supercharging Engine Adds 500 i.h.p. to Output of m.s. Tiradentes' Four-Cycle Diesel Engine. Speed is Increased, Trips Are Shortened, and Excess Business is Turned Away

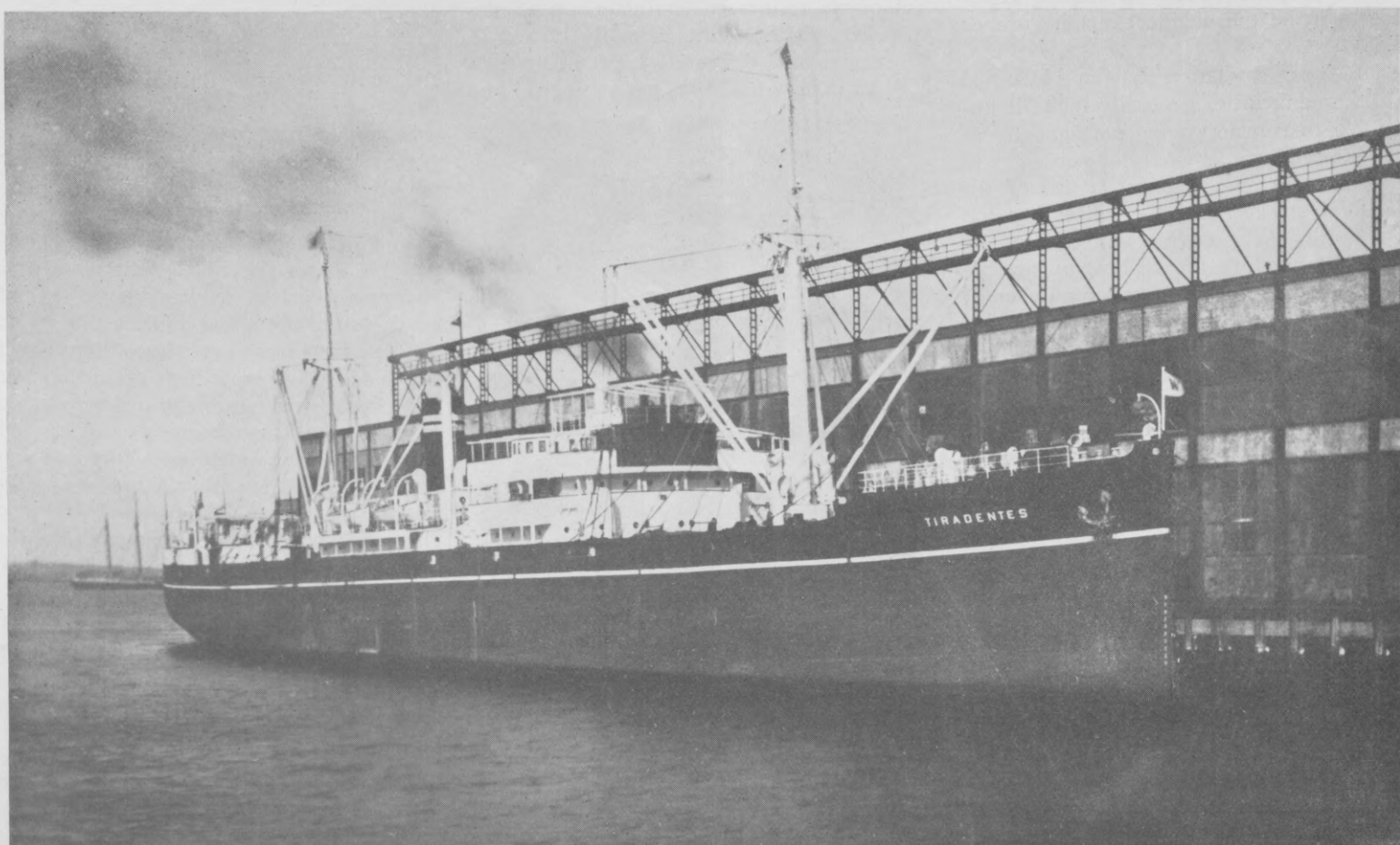
ling power, the advantages of over-rating are correspondingly more pronounced, but in addition to that, there is realized a series of ship-operating features which are very attractive from the owner's point of view and which will become apparent from what follows.

The *TIRADENTES* was described in *MOTORSHIP* for January and May, 1923, before she was fitted out with the equipment necessary for operating her main engines at continuous overload. She was placed in commission a little over a year ago and although originally intended to develop 3,100 i.h.p. in twin engines, she has been operated uninterruptedly since August, 1923, at a steady engine output of 3,600 i.h.p. We made visits after two different voyages before giving

publicity to the remarkable results obtained as we desired to feel convinced of the practicability of the step.

During a recent visit of this noteworthy vessel at the port of New York, Captain Nils Hjul, representative in this city of the Wilhelm Wilhelmsen Line, Tonsberg, Norway, kindly permitted us to go on board and to acquaint ourselves with the details of her operating technique. We were given every possible assistance in this by Captain Erik Erikson and Chief Engineer Anker Ingebretsen.

Designed originally to develop their 3,100 i.h.p. at a speed of 125 r.p.m. and a mean-effective pressure of 88.5 lbs. per sq. in., these twin oil-engines were used in conjunction with a hull and propeller that prevented the attainment of anything like the rated revolutions. It will be remembered from our description of January, 1923, page 45, that the *TIRADENTES* has the following characteristics, all of which have a bearing on the unique manner in which she is now being operated:



By equipping her four-cycle Diesel engines with superchargers, the speed of this motorship was increased by one knot, which enables her to command full cargoes every voyage. Our illustration shows the *Tiradentes* at the Municipal Pier, Boston

Loaded displacement.....	14,995 tons
Net-cargo capacity.....	10,000 tons
Dead-weight capacity.....	10,875 tons
Length, overall.....	416 ft.
Breadth	54 ft.
Depth	28 ft.
Speed	11½ knots

Her engines consist of two Burmeister & Wain-designed four-cycle Diesel type machines constructed in Germany under license for the Deutsche Werft, of Hamburg, builders of the hull.

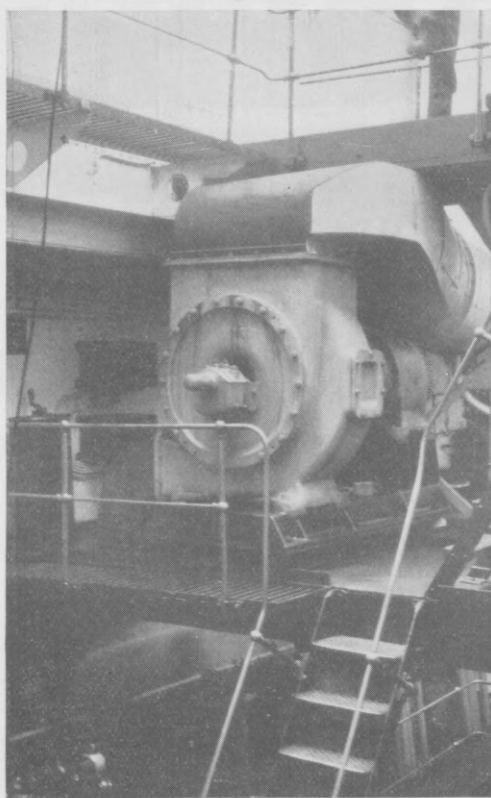
They are very exact copies of the Danish design, and might readily be mistaken for a Copenhagen product if it were not for the AEG nameplate of the General Electric Company, of Berlin. Following are the principal engine dimensions:

Original power per engine	1,550 i.h.p.
Original total power.....	3,100 i.h.p.
Present total power.....	3,600 i.h.p.
Bore	24.803 ins. (630 mm.)
Stroke	37.795 ins. (960 mm.)
Designed speed.....	125 r.p.m.
Mean-indicated pressure (original)	88.5 lbs. per sq. in.
Original propeller diameter	11 ft. 9¾ ins.
Present propeller diameter	11 ft. 5¾ ins.
Propeller pitch.....	11 ft. 5¾ ins.
Oil-fuel used.....	26 degs. Beaume

The original figures were determined upon when the entire vessel was first designed and represented the best estimate of all the governing variables that could be made at that time. Knowing, however, that it is not humanly possible to hit upon correct values for all of them before the ship makes the first trip under her own power, designers generally allow for adjustment by making the propeller subject to change after the first trial run. If the wheel has too flat a pitch, it will be necessary to run the engine at a speed faster than the one intended before the propeller picks up enough resistance to make the engine exert its proper m.i.p.

Vibrations, cavitation at the blade-tips and other difficulties generally make it undesirable to run an engine permanently at an overspeed such as would be necessary to compensate for the deficient power of the individual strokes. If the wheel has too great a pitch, the engine will develop its rated m.i.p. before the full r.p.m. are attained. Because of the smaller number of power strokes made per minute, the engine fails to deliver its rated output unless a higher m.i.p. is to be tolerated. The latter need not be proportional to the amount of power that is lacking, because an increase in mean pressure also speeds up the engine and increases the number of effective strokes that are made per unit of time. However, a higher m.i.p. brings with it poorer economy, a certain amount of after-burning, and over-heated exhaust-valves, unless measures are taken to counteract these troubles.

To judge by the trials of a sister-ship of the TIRADENTES, the TENNESSEE, the figures for horsepower, r.p.m., and propeller pitch had been correctly chosen. According to the summary which we printed, the TENNESSEE attained a speed of 12.6 knots while the engines turned at 144.3 r.p.m. with a m.i.p. of 90.0 lbs per sq. inch, and an out-



Supercharging blower is accommodated in a space in the engine-room having little value for other purposes

put of 1,820 i.h.p. Her displacement at the time was only 4,415 tons at a draft of 9 feet, 8 inches. It was therefore reasonable to expect that a full loading of the ship would slow down the engines to their rated speed of 125 r.p.m., which, in combination with designed m.i.p. of 88.5 might well have been expected to yield the required 1,550 i.h.p.

Nothing of the sort occurred, however, owing probably to some peculiarity of the hull or an unforeseen characteristic of the propeller. The engines actually turned at 104 r.p.m. and delivered 1,350 i.h.p. each with an m.i.p. of 92.3 lbs per sq. inch. The



Chief Ingebreetsen, Capt. Hjul and Capt. Eriksen, from left to right. They believe in letting the engines do the overtime

propeller on the TIRADENTES is solid and has its blades cast integral with the hub, so that to decrease the pitch would have meant dry-docking the ship and jacking the wheel off the shaft. Naturally the under-powering was not discovered until the ship had been loaded and placed in commission, with the result that a lay-up would have been decidedly awkward and expensive.

The first thing which her German builders did to remedy the trouble was to burn two inches off the tips of all four propeller blades, thereby reducing the diameter to 11 ft. 5¾ inches. We are told that the amount of improvement thus effected was about equivalent to that which the bo'sun might have accomplished by paddling at the bow. The engine r.p.m. was not affected, nor, indeed, was the ship's speed either. Still, the decision not to replace the wheels remained unshakable, probably because two exactly similar spares were then and are still stowed in No. 5 hold.

Next it was decided to run at a higher m.i.p. and by increasing this to 101 lbs. per sq. inch an output of 1,560 i.h.p. was realized, while the exhaust temperature rose from a normal of 740° F. to the somewhat alarming figure of 814°. But the color of the exhaust was no longer above suspicion, and the engines still would not run at more than 110 r.p.m.

In the meantime the internal-combustion world had been set agog by reports of super-charging applied to Diesel engines. Originally developed to make possible the flying of aeroplane-type gasoline engines at high altitude, this method soon came up for consideration in connection with oil engines. Or it may have been that oil engines of the two-cycle type, some of which are fitted with independently-driven turbo-blowers for the supply of scavenging air that gave the first impetus to the super-charging idea. Its application to two-cycle engines with attached reciprocating air-pumps has been a matter of long standing, not only for valve-scavenging machines, but also for auxiliary-port scavenging engines.

In the former it has not been generally possible to get the full benefit from super-charging because valve-equipped cylinder heads would not stand high mean-pressures and temperatures; but where these engines are installed in plants high up in the mountains, it appears feasible to make up the loss in rating by supercharging with an independent scavenging blower. Port-scavenged two-cycle engines with a simple conical cylinder head have, of course, been super-charged from the beginning and have accordingly developed the same mean pressures as four-cycle engines.

Supercharging four-cycle engines with a view of obtaining mean pressures higher than those commonly accepted as normal has been the development most recently attempted. A very full report on the subject was published about a year ago in the German Engineering Societies' Journal. The author—a notable professor—obviously knew he was playing entirely safe by concluding from the tests which he de-

scribes that an artificial increase in the mean pressures and temperatures obtainable in a four-cycle engine by means of supercharging would never result in ruined exhaust valves and cracked cylinder heads.

Either the Allgemeine Electricitaets Gesellschaft of Berlin decided to take a leaf out of the Herr Professor's book or they were compelled to do something by way of making good with their installation on the TIRADENTES without incurring big expenses of a layup and alterations. It is possible, also, that they had already drawn their own conclusions from shop tests showing results substantially similar to those reached by the German scientist. Possibly they may be willing to publish them later.

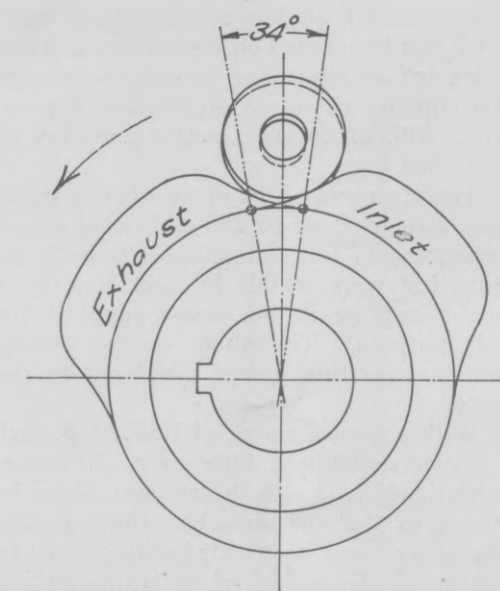
At all events they installed a blower on the TIRADENTES. It is direct-driven by a 220-volt 150-ampere d.c. electric motor running at 2,000 r.p.m. and is connected to an inlet manifold running along the engine parallel to the D-shaped exhaust-header. As is readily apparent from our photograph, both the air-duct between the blower and the engine as well as the air-manifold are built of sheet-metal, and the blower has been neatly accommodated on one of the uppermost engine-room gratings. We regret that no information was available about the cubic capacity or the weight of the blowing outfit; but surely the latter can not exceed two or three tons at the most. The job is thoroughly carried out and there are no suggestions of patchwork about it, but it is apparent also that the work was neither time-consuming nor expensive.

That the ship has been operated with this equipment for a number of months has already been stated; a close-up view of the actual engine performance is afforded by the following table of operating figures:

M.S. TIRADENTES

Engine-Room Log of Sept. 4-5, 1923.

Draft	25 ft. 0 in.
Wind	Calm
Sea	Light swell
Absolute time.....	24 hrs. 22 min.



During 34° travel of the crankshaft both exhaust and inlet valves are open and a blast of air from the blower clears the combustion space of waste gases

Distance, observed.....	286 naut. miles
Distance by log.....	275 naut. miles
Speed observed.....	11.74 knots
Speed, by log.....	11.30 knots

At the same time the following observations were recorded by Mr. Anker Ingebrechtsen, who has been Chief engineer of the TIRADENTES ever since she was put in commission, and who has been extremely courteous in furnishing data to MOTORSHIP:

M.S. TIRADENTES

Captain's Log of Sept. 4-5, 1923.

	Port	Stbd.
R.p.m., Sept. 4.....	121.5	121.0
R.p.m., Sept. 5.....	120.4	120.0
R.p.m., mean.....	120.9	120.5

M.i.p., Sept. 4.....	105.9	107.7
M.i.p., Sept. 5.....	107.6	106.7
M.i.p., mean.....	106.8	107.2

I.h.p., Sept. 4.....	1,805	1,826
I.h.p., Sept. 5.....	1,819	1,800
I.h.p., mean.....	1,812	1,813

Fuel to main engines in 24 hrs.,	11.8 long tons
Fuel consumption per b.h.p.-hr.	0.308 lb.
Fuel fed to auxiliaries in 24 hrs.	0.80 ton
Total fuel in 24 hrs.....	12.60 tons

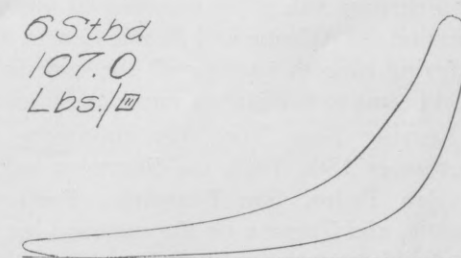
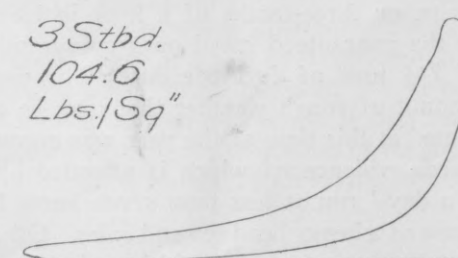
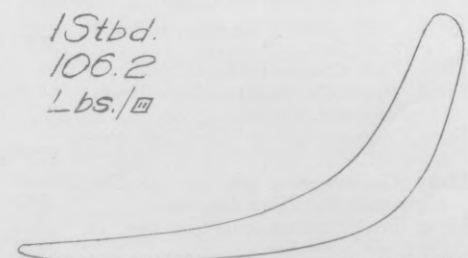
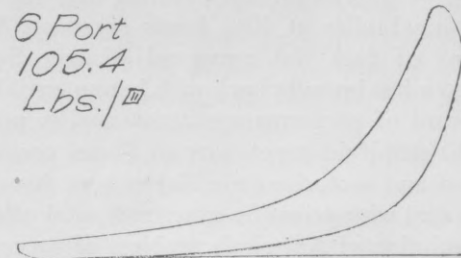
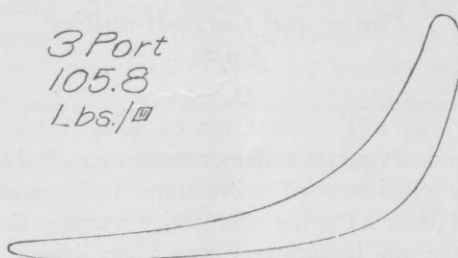
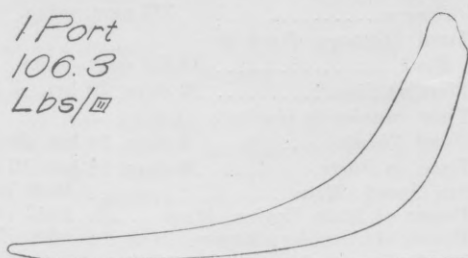
Distance @ zero slip.....	329 naut. miles
Distance, actual.....	286 naut. miles
Slip	13%

Power to turbo-blower.....	33.0 k.w.
Volts of turbo-blower.....	220
Amperes of turbo-blower.....	150
Speed of turbo-blower.....	2,080 r.p.m.
Air pressure per sq. in.....	0.845 lb.

That the turbo-blower fully comes up to the expectations of the engineers who installed it is thus fully borne out by the figures. Additional evidence of a graphic kind to show that the TIRADENTES is being operated on thoroughly sound principles is furnished by the series of indicator cards reproduced herewith. These are undoubtedly "fat" cards, but the clean slope of the expansion line right down to the tip of the "toe" leaves no doubt that combustion occurred promptly and took place without smoke or after-burning.

Without a blower the volumetric efficiency of a four-cycle engine is appreciably less than unity. A slight vacuum must be created and maintained in the cylinder during the suction stroke before any air from the outside atmosphere will enter, and the charge is further reduced in density because of the heating which it undergoes as it comes in contact with the valves and cylinder walls. The weight of oxygen actually present in the cylinder at the moment when the inlet valve closes is what determines the amount of fuel that can be burnt. As soon as this is exceeded, after-burning becomes serious enough to interfere with the successful operation of the engine.

It is apparent from the indicator cards as well as from Chief Ingebrechtsen's reports about the performance of the engines, that the blower improved the filling of the cylinders sufficiently to make possible satisfactory and permanent operation at the high power which is here recorded. The blower does two things. Owing to the



"Fat" cards are produced on the Tiradentes day in and day out because the supercharging blower furnishes sufficient air for complete combustion of the fuel. The amount of air handled by an engine is what determines its practical capacity, no matter whether the air comes from a blower or from increased cylinder dimensions. Hot compression was brought back to 470 lbs. by shimming down the piston 0.197"

fact that there is an interval in the valve-operation of each cylinder during which both inlet and exhaust valves are open at the same time, the air driven by the blower is given a chance to sweep through and clear the combustion space of a considerable quantity of exhaust gases which the piston has failed to expel during the regular exhaust stroke. This is of importance not only because of the oxygen which is ordinarily crowded out by these waste gases, but also because the contamination of the fresh charge adversely influences combustion. In addition to scavenging the cylinder, the blower also puts the incoming charge under a positive pressure, thereby increasing its density and its capacity for consuming fuel.

We did not permit our keen interest in the new operating method to make us forget the question of exhaust valves, members which are naturally thought of first when it comes to overloading an engine. The exhaust temperature on the TIRADENTES is unquestionably high, varying from 806° to 842°, and would indicate after-burning if the engines were running under circumstances otherwise normal. However, in the case under consideration the exhaust is entirely invisible, and there are no soot deposits on the exposed engine members. Lying with figures is a favorite pastime of statisticians, but we think it hard, nevertheless, for anyone to get around the figures on exhaust-valve performance which we saw recorded in the log of TIRADENTES. Had we been told that operation at super-power does not affect the exhaust valves at all, we might have been skeptical. Before installing the blower, each exhaust valve could be used for 60 days without attention and since the blower began to be used as a

power-booster, 40 days of satisfactory operation can be counted on from every exhaust valve before regrinding becomes necessary. The quality of oil as supplied to the engines will, of course, cause a variation of this time.

Temperatures of the piston-cooling water rose somewhat when 250 additional horsepower began to be developed by each engine, but were readily brought back by a slight increase in the water supplied for this purpose. The effect on the piston-water circulating pumps could not be detected.

With a normal rating of 1,550 i.h.p. each cylinder develops a little over 250 horsepower, which is also the amount added by means of the turbo-blower. Consequently the blower may be credited with adding an entire cylinder to each of the two propelling units. Inquiries of American manufacturers as to the estimated costs of a similar complete blowing outfit showed that the entire domestic cost including erection would not exceed \$2,000, and that the total weight would be around 3,000 lbs. Since the blower takes care of two engines each delivering 250 excess i.h.p., the total increase in capacity attributable to the blower is 500 i.h.p. The weight of the "seventh cylinder" thus virtually added to each engine amounts to 1,500 lbs. and its cost to \$1,000. Surely the production of Diesel power weighing 6 lbs. per i.h.p. and costing \$4 per i.h.p. is altogether without parallel in the history of oil or steam engine building.

But it is not only the technical aspects of supercharging by means of a turbo-blower which interest us here. The additional speed imparted to the vessel by this means amounts to about one knot, and that in turn shortens the voyage from New

York to Buenos Aires by one day. As the TIRADENTES often carries a cargo valued at \$4,500,000 the enormous return to her owners from the blower investment due to savings of interest and insurance for that one day are self-evident—one factor of motorship operation never yet taken into account by steam adherents when making comparisons with steamers.

By far the most striking feature of the TIRADENTES' present operation is the fact that she charges the same uniform rates as the steamers which ply the same route. Erik Erikson, master of the TIRADENTES, informs us that the extra day gained by the use of the blower is frequently of great value in getting to the unloading berths ahead of competing ships. The strategic advantage of this from a commercial point of view is so great that shippers might conceivably be willing to pay premium freight rates in order to secure it. In any event it ensures cargoes and preferential bookings.

Last but not least, is the one-hundred per cent perfection with which the schedules of the TIRADENTES have been maintained, a service feature also highly valued by shippers. In spite of charging fully competitive rates, the owners of the TIRADENTES always have more business on hand for her than she can handle—and, of course, she carries about 750 tons more cargo than a steamer, the quantity varying according to the length of voyage, and class of cargo. With her fuel consumption of 11.8 tons a day they reap the full benefit of characteristic motorship economy. What they really possess is a 11½ knot ship at the cost of a 10½ knot craft of smaller capacity (but similar dimensions) combined with maximum fuel economy fully offsetting the 12% higher first cost of the Diesel powered vessel.

Converted Shipping Board Steamer's Maiden Voyage

RETURNING to New York after her first voyage as a single-screw 7,754 tons motorship, covering over 13,300 nautical-miles at 10¼ knots speed on 390 tons of fuel, the converted steamer SEEKONK has brought back with her an enviable record of performances at sea and in port. The manifold superiority of Diesel propulsion and motorized auxiliaries was demonstrated with scientific exactitude, and offers a solution of America's problem of successfully maintaining a merchant marine—both foreign-going and coastwise. She docked on February 6th after touching at various ports on the Atlantic and Pacific Coasts, and carrying cargoes varying all the way from steel beams to full-sized equestrian statuary.

Leaving New York for Baltimore on November 18th, 1923, the SEEKONK called at San Pedro, San Francisco, Portland, Seattle, and Tacoma on the outward leg of her maiden voyage. She returned to New York via San Francisco, San Pedro and the Panama canal. Her performance and eco-

Seekonk Completes Brilliant Passage to the West Coast Bringing Back Precise Records of Propelling-Power and Cargo-Handling Costs

nomical operation demonstrates conclusively the efficiency of motorships in coastwise services. During the entire voyage there were no involuntary stops or delays on account of the engine-room or deck machinery. Her average speed was 10.29 knots, or three-tenths of a knot in excess of the guaranteed speed on a consumption of 7½ tons of fuel per day. The usual amount of rough weather that may be expected at this time of the year was encountered, evidence of which is afforded by a two days' run at less than seven knots because of a heavy head sea and gales. Otherwise her mean speed would have been even higher. A tabulation of the noteworthy results achieved is given as follows:

Performance on Round Voyage	
Distance, at Sea.....	12,545 naut. miles.
Distance, in Harbors and Rivers	777 naut. miles.
Total Distance, Dock to Dock	13,322 naut. miles.
Time, at Sea.....	50 days, 20 hrs. 2 min.
Time, running in Harbors and Rivers	4 days, 14 hrs. 39 min.
Time, in Ports.....	28 days, 18 hrs. 10 min.
Sea Speed, Mean.....	10.29 knots.
Power of Main Engine, Mean.....	2,252 i.h.p.
Power of Auxiliary Engine, Mean....	100 i.h.p.
Total Power Main and Auxiliary Engine	2,352 i.h.p.
Total Fuel Consumption, Main and Auxiliary Engines at Sea.....	382.5 tons.
Total Fuel Consumption, Donkey-Boiler at Sea.....	7.5 tons.
Total Fuel Consumption at Sea.....	390. tons.
Total Fuel Consumption in Rivers, Harbors and Canal.....	25.7 tons.
Fuel Consumption in Port, all purposes	19.7 tons.
Mean Consumption per day at Sea, Main and Auxiliary Engines.....	7.52 tons.
Mean Fuel Consumption per day, in Port, all purposes.....	0.70 tons.
Mean Fuel Consumption per i.h.p. hour, Main and Auxiliary Engines on voyage	\$298 lbs.
Distance per ton of Fuel.....	32.8 naut. miles.



Unloading lumber from the converted steamer *Seekonk*, now an economical single-screw motorship. The cost of handling cargo is but $\frac{3}{10}$ of a cent per ton

For three days of the run from January 17th to 20th, sea conditions were good, and the r.p.m. of the propeller did not vary two-tenths of a revolution for the daily averages. Following is an extract from the engine room log covering this three-day period:

Best Three Days Run	
Speed by observation	10.66 knots
Propeller speed	86.1 r.p.m.
Slip	5.3 percent
Fuel per 24 hrs. main and aux. engines	7.43 tons
M. i. p. main engine	89.0 lbs./sq. in.
M. i. p. aux. engines	70.7 lbs./sq. in.
Power main engines	2,285 i.h.p.
Power aux. engines	120 i.h.p.
Power main and aux. engines combined	2,405 i.h.p.
Fuel oil per i.h.p.-hr. main engine only	0.303 lb.
Fuel oil per i.p.h.-hr. main and aux. engines.	0.288 lb.

The set of cards shown were taken on the main Cramp-Burmeister and Wain Diesel engine two days before getting back to New York. They give evidence of the very even division of load among the working cylinders, and indicate that they are also functioning well in all other respects. The rated power of the engine is 2,300 i.h.p., which is practically the load averaged for this maiden trip.

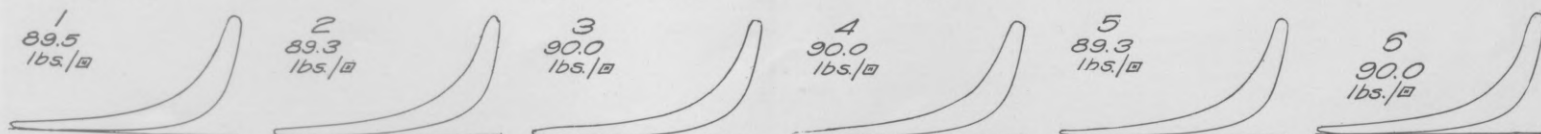
Cramp's re-designed and re-built winches, capstan, and windlass, Westinghouse electrically motorized and controlled, replace the former deck steam auxiliaries, parts of the old equipment being retained in converted form; electric drive has also been applied to all engine-room auxiliaries. Two separate kilowatt-hour meters have been located on the switchboard. One of these exclusively registers the current consumed for the cargo-handling winches and the other records the current used by all the ship's above and below-deck auxiliaries and appliances. These meters, according to Chief-Engineer Oscar Olson, are carefully read at the start and finish of each day's work and a close check is made at the same time of the oil in the daily service tanks. The figures thus obtained show a total of 10,445 kilowatt hours consumed by the above and below-deck auxiliaries covering a period of 83 days and 18 hours with a fuel consumption of 55 barrels of fuel, which at San Pedro cost one dollar a barrel.

Electric auxiliaries consumed 5,470 kilowatt hours for handling 9,489 tons of varied classes of cargo at a cost of 0.003046 dollar or slightly over three-tenths of a cent per ton. Prior to her conversion it had been estimated that the electrification of the deck auxiliaries would result in a saving of over

\$15,000 per year as compared with steam machinery and the present record made by the *SEEKONK* indicates that the estimate was a conservative one. The total annual fuel saving will be in excess of \$30,000. With the increasing price of fuel this saving may be increased to \$40,000 or more.

She carries 1,000 tons of deadweight cargo more than before her conversion, the actual gain in cubic hold space being 17,768 cubic feet. The balance of the difference in tonnage is due to the fact that she carries less fuel and water. Her total grain capacity is 407,580 cu. ft. Hence, aside from economy in operation she has a greater earning power. This means a splendid rate of interest on the investment necessary for the conversion to Diesel power.

Some of the cargo, a sample of which was the crated and bulky statue of a circus rider, proved very delicate to handle, while other varieties, such as $3\frac{1}{2}$ -ton steel beams, demonstrated the facility with which clumsy material can be handled by means of electric hoisting machinery. A million feet of lumber were loaded and unloaded without breaking a single piece. Although the controllers were manned by stevedores who had never operated an electric winch before, the cargo remained under perfect control at all times.



Indicator cards of the single-screw Diesel engine of the *Seekonk*. We have traced these cards from the originals as closely as is possible

Upon being asked whether steam auxiliaries could be applied with equal success to the island-platform arrangement first carried out on the *SEEKONK* and illustrated in our November and December issues, Chief-Engineer J. F. Metten of Cramp's Shipyard replied as follows:

"Electric winches, due to the flexibility of electric cable are best adapted for this service and the maintenance is very low. The steam pipes necessary for steam winches are inconvenient to place and are the source of considerable expense to keep in repair. In fact the maintenance of steam pipes is one of the biggest overhead items on a steamship."

The foresight of Cramp's in erecting the deck house and elevating the deck auxiliaries resulted in the operators, the United American Lines, securing a cargo of a million feet of lumber from the Pacific Coast to New York. The lumber was piled about 10 feet high on the deck, a method of stowing rendered especially convenient by the elevated location of the deck auxiliaries. The *SEEKONK*'s engineers are enthusiastic over the installation, as only slight adjustments were necessary in handling altogether 10,000 tons of cargo. We understand that the idea of the island platforms emanated from J. D. Tomlinson, general manager of the American-Hawaiian S. S. Co., who is one of the most experienced ship operators in the country.

Westinghouse controllers and motors on the *SEEKONK* embody the watertight features of their previous successful installations on the motorships *WILLIAM PENN* and



We notice from this illustration that the deck of the *Seekonk* is piled with lumber, rendered possible by the specially built island platforms on which the electric winches are mounted

CONVERTED STEAMER *SEEKONK* — MAIDEN VOYAGE

(Averages of four longest legs)

	New York to Panama	Panama to San Pedro	San Pedro to Panama	Panama to New York	New York to San Pedro	San Pedro to New York
Draft.....	13' 6"	13' 3"	21' 6"	21' 6"	13' 4"	21' 6"
Running time, hours at sea.....	185.8	277.1	281	207.4	462.9	488.4
Distance observed, miles.....	1,960	2,913	2,913	1,960	4,873	4,873
Average speed at sea, knots.....	10.55	10.51	10.36	9.45	10.53	9.98
R. P. M.	85.9	88.8	85.01	83.3	87.8	84.3
Slip.....	6.3	9.5	6.9	13.3	8.3	9.5
I. H. P. Main engine.....	2,212	2,338	2,259	2,230	2,300	2,247
I. H. P. Auxiliary engine.....	100	100	100	100	100	100
I. H. P. Main and auxiliary engines..	2,312	2,438	2,359	2,330	2,400	2,347
Fuel consumed at sea, tons per day....	57.4	90.3	86.8	65.8	147.7	152.6
(Main engine.)						
Fuel consumed at sea, tons per day... (Auxiliary engines.)	7.42	7.82	7.42	7.61	7.66	7.5
Pounds oil per I. H. P., main and auxiliary engines.....	0.299	0.298	0.293	0.299	0.298	0.298
Fuel consumed, donkey boiler, tons...	1.2	1.2	.....	0.43	2.4	0.43
Number stormy, days.....	.....	3	.....	2	3	2
Maximum speed per day, knots.....	11.2	11.7	11.0	11.0	11.7	11.0
Minimum speed per day, knots.....	9.4	6.8	10	6.7	6.8	6.7
Miles per ton of fuel.....	34.1	32.3	33.6	29.8	33.0	31.9

CONVERTED STEAMER "SEEKONK" — MAIDEN VOYAGE

	In port	At sea
Lubricating oil consumption.....	26	120 gals.
For general lubrication.....	6	245 gals.
For cylinder lubrication.....	40	75 gals.
For compressor lubrication.....		
Total.....	72	440 gals.
Average per day.....	2.51	7.86 gals.

MEAN FUEL CONSUMPTION OF AUXILIARIES

	Tons per day
Donkey boiler when in operation.....	0.41 ton
One auxiliary in port, when not handling cargo.....	0.27 ton
When Handling Cargo —	
Two auxiliary engines in operation from 8 A. M. to 5 P. M. and one auxiliary engine in operation remaining time.....	0.42 ton

LOADING AND DISCHARGING CARGO

Total cargo handled.....	9,489 tons
K.W. hours input to winch motors... 5,470 tons	
Proportion of total fuel consumption, auxiliary engines, for K.W. input to winch motors.....	4.1 tons
K.W. hours per ton of cargo handled..	0.576 ton
Pounds of oil per ton of cargo handled.	0.97 ton

CALIFORNIAN. The winch motors on the *SEEKONK*, although rated at 20 h.p., 10 h.p. less than those of the other two ships, handle the cargo faster and the motors generate current on the downward movement of the load at an even lower speed than that which is required on the two previous installations.

Itemized details of the work of handling cargo on the *SEEKONK* are given in an appended table, from which it is apparent that the summaries already given are based on a very complete set of direct observa-

tions painstakingly made. Total auxiliary kilowatt hours generated during the trip amounted to 10,455, of which 4,975 or 47.6% were used for general purposes aboard the ship and 52.4% for handling cargo. As has already been stated, 55 barrels of fuel costing \$1 apiece were consumed in generating the 10,445 kilowatt hours, and 52.4% of \$55, the share of the costs chargeable to cargo-handling amounts to \$28.81. Dividing the latter by the number of tons handled—9,489—results in a cost per ton of \$0.003046.

Details of Cargo Handling

Date	Ports	Loading or discharging cargo	Nature of cargo	Winch hours	K. W. H. Consumed cargo handling	K. W. H. Consumed ship's use	Tons of cargo	Pounds of fuel oil
Nov. 15-17.....	Baltimore.....	Loading.....	Steel pipe, steel beams....	120	670	458	1,210	1,980
Nov. 19-22.....	New York.....	Loading.....	General.....	98	550	668	610	2,150
Dec. 12.....	Los Angeles.....	Loading and unloading....	Steel, general.....	101	380	181	680	940
Dec. 15-17.....	Frisco.....	Discharging.....	Steel, general.....	130	480	382	710	1,490
Dec. 20-30.....	Portland.....	Discharging and unloading.	General and lumber.....	434	1,470	1,166	2,883	4,706
Dec. 31.....	Astoria.....	Loading.....	Lumber.....	13	60	156	91	300
Jan. 1-4.....	Seattle.....	Loading and discharging..	Lumber and general.....	128	500	469	875	980
Jan. 5-8.....	Tacoma.....	Loading.....	Lumber.....	504	1,000	961	1,720	3,485
Jan. 12.....	Frisco.....	Loading.....	General.....	28	140	159	210	495
Jan. 14-15.....	San Pedro.....	Loading.....	General.....	48	220	375	500	850
Total.....				1,604	5,470	4,975	9,489	17,376

How the World's Largest Diesel was Built

It may be said at this point that the six-cylinder engine at the corresponding mean-effective pressure would develop 17,150 b.h.p., thus surpassing the expected load by 43%.

The complete six-cylinder engine was started for the first time on January 4, 1917; and on February 3d, a series of trials was begun during which load and speed were gradually increased. At regular intervals the engine was opened up and every time found in perfect condition. On March 18th, for the first time a continuous run of 12 hours' duration with a load of 10,000 b.h.p. was successfully carried out and during the week this load was gradually increased first to 11,500 and then finally to 12,000 b.h.p.

The engine, when opened up, was again found perfect, and on March 31, 1917, a continuous run of 5 days was begun with loads varying from 10,800 to 12,000 b.h.p. One can freely say that there was no trouble whatever, although towards the end of the run it became necessary to use a very bad fuel and an exceedingly bad lubricating oil.

At this stage the engine had made already 2,100,000 revolutions. It was then completely taken down and thoroughly in-

Special Story Relating How the Problems of Constructing a Marine Engine Which Developed Over 17,000 Shaft H. P. Were Overcome

By F. ENGLERT.

PART IV

(Continued from page 119. Feb.)

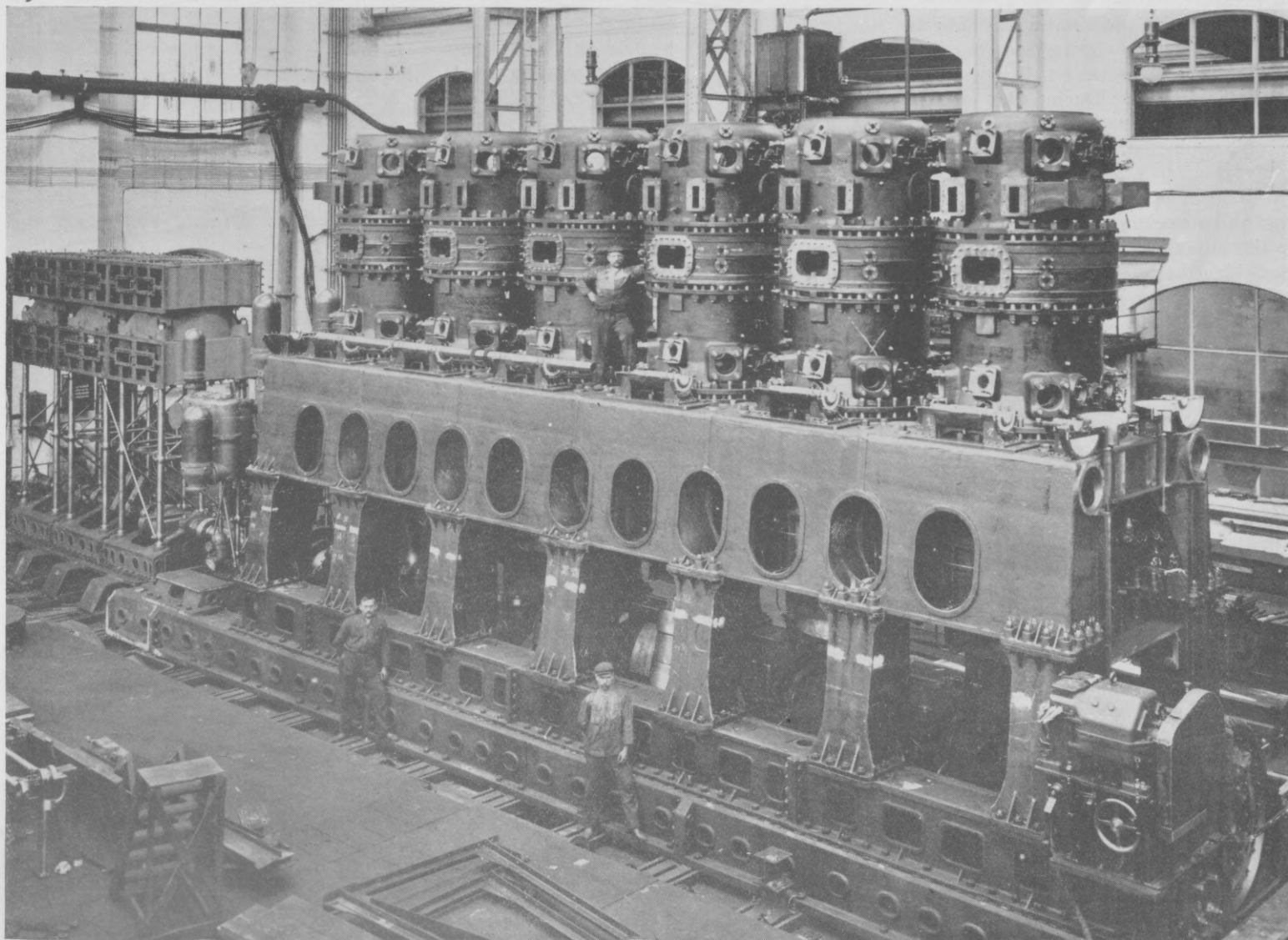
spected. Cylinders, heads, and pistons were found in excellent condition and also all other parts in splendid shape with the exception of a few minor defects which were caused by the bad lubricating oil. The program of this trial covered also a number of reversing maneuvers. It was thought that a close investigation of the behavior of the engine when reversing was important enough to warrant an exhaustive program of such trials to be carried out.

For absorbing the power developed by the experimental cylinder as well as the six-cylinder engine there was available a water-brake of 10,000 b.h.p. capacity and a 2,000 b.h.p. D.C.-dynamo. Either unit could be coupled at will with either engine. The shaft of the water-brake carried 12 perforated steel discs of 4'13/64" dia., on to which a number of angle irons were riveted

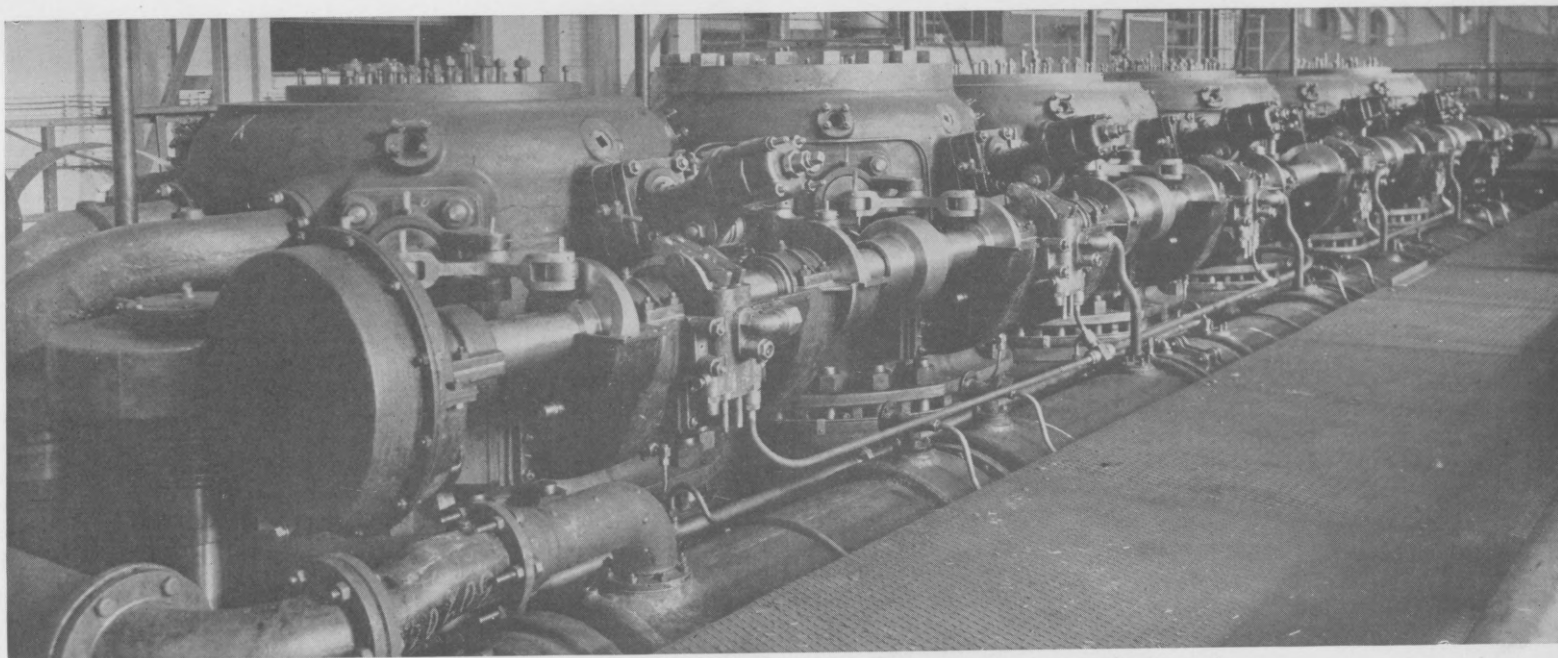
to increase the turbulence. The moment of friction transmitted by the water from the rotor to the casing was measured by means of a traveling weight.

The leading idea when planning the program for the reversing trials was to imitate the operating conditions at sea as closely as possible. Already the numerous previous maneuvering trials had formed part of this program. Now the intention was to broaden its scope by trying to imitate the inertia reactions on propeller and engine due to a ship in motion. For this purpose a flywheel of 13'-7/16" dia. having a moment of inertia of 4,740,000 lbs. ft. was coupled to a 150 r.p.m. D.C.-motor and the current generated by the already mentioned 2,000 b.h.p. dynamo, which was driven by the engine, fed into it. When the engine was reversed the energy of this flywheel had first to be absorbed by the engine by way of the motor generator and the dynamo, then an equal amount of energy reloaded into it.

The volume of the starting air tanks was 229 cu. ft. and the pressure dropped from 850 to 540 lbs. per sq. in. during one reversal. Thus no less an amount than 5,000 cu. ft. of free air was used for one reversal. This excessive consumption was due to the



View of M.A.N. 6-cylinder 12,000 b.h.p. 2-cycle double-acting Diesel engine showing cast-steel bedplate, cast-steel columns, supporting entablature and cylinders in place. Forward of engine are seen the three double-acting blowing cylinders for scavenging air; and cooling-water pumping plant direct driven between engine and scavenger



Camshaft and valve operating gear of the 12,000 shaft h.p. M. A. N. Diesel engine

design of the starting cams. In order to start the engine safely from any crank position and in any direction, these cams held the valves open over such a wide crank angle that two valves were open simultaneously for some time. Since the exhaust ports opened shortly after the starting valves closed, there was little chance for the starting air to expand, on the contrary it escaped at very high pressure. This in turn brought about a pretty high scavenging air pressure.

Later the starting mechanism was entirely changed so that only during the first few revolutions the valves were held open over a wide crank angle. During the ensuing turns and until the engine began firing the angle of opening was materially reduced and only one valve open at a given time. This method of operation resulted in lower exhaust and scavenge pressures. One may judge the effect of the change by the time during which the receiver pressure dropped from 923 to 426 lbs. which was as follows:

	Time	Speed
Old Method.....	6.5 sec.	70 R.P.M.
New Method.....	19.3 sec	80 R.P.M.

So much about the development work on the 12,000 b.h.p. engine.

A few remarks about the design may be appreciated.

The baseplate was made of three cast steel pieces. It contained the nine main bearings of the 6-throw crankshaft. Two rows of seven cast steel columns connected the baseplate with the entablature for the cylinders which itself was built up of six pieces and contained the water cooled cylindrical crosshead guides. Mounted on it were the six cylinders. Four horizontal camshafts were fitted for the valve operation, driven at each end by means of two pairs of vertical shafts. The engine was to be a port unit for marine use.

Fitted on the starboard side was the control station of the operating engineer. Here were placed two fuel-oil pumps, each having six plungers and two ignition-oil pumps (for use when running engine on tar-oil fuel) with 12 plungers each, also

the hand control for starting and reversing operations.

Compressed air was used exclusively for the operation of the different mechanisms

necessary for maneuvering and for the control of the fuel and the starting air. Directly operated by compressed air were: safety and vent valves on the cylinders, the

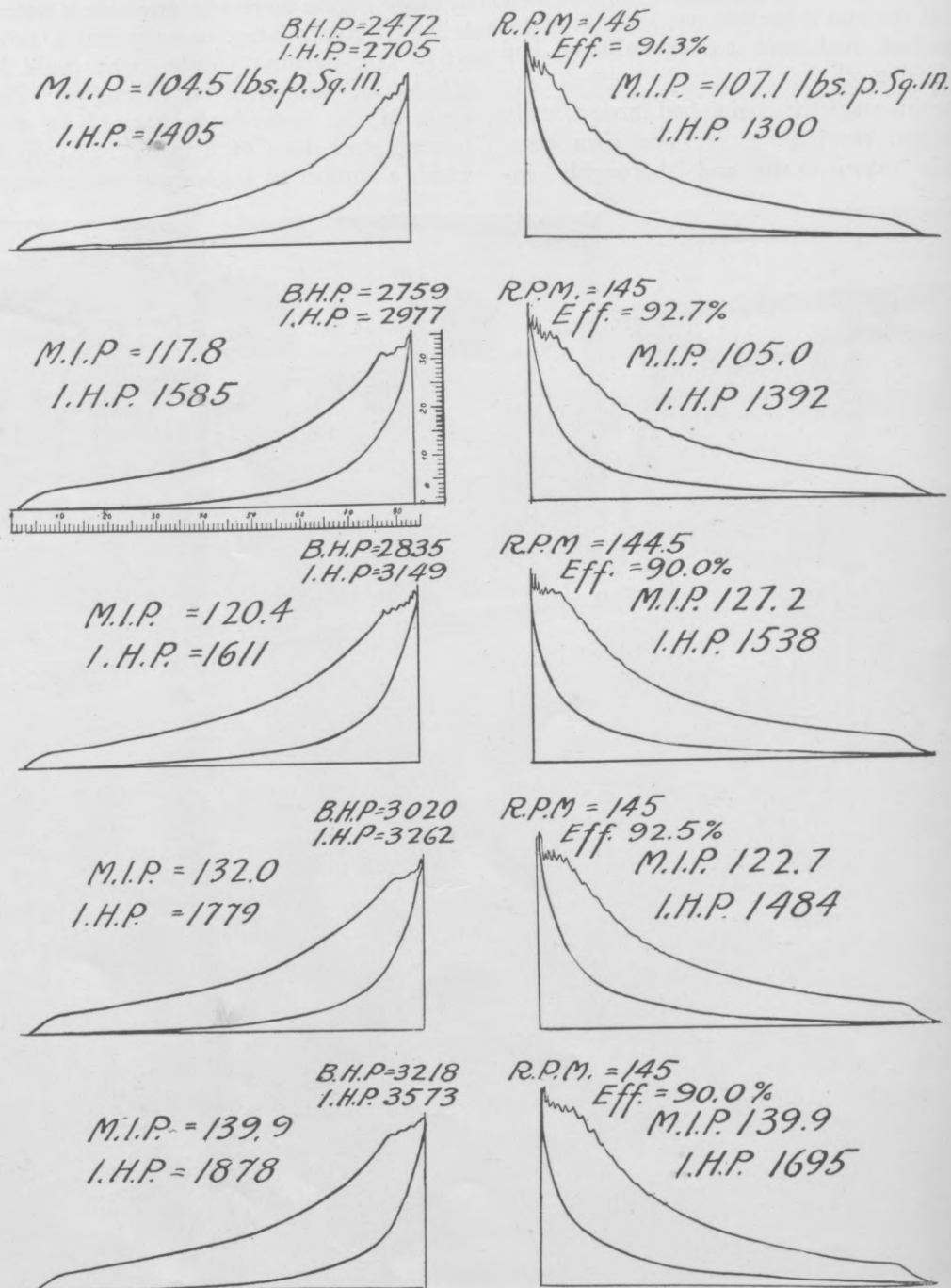


Fig. 10. Indicator cards taken on test of the 12,000 s.h.p. Nurnberg Diesel engine

reversing valves, the starting air and blast air relays. In order to avoid air losses, the pressure in the starting and blast air pipes was relieved when the engine was standing still, and also in the starting air pipes when engine was running. Relays operated by the reversing valves actuated the starting air valves in the upper heads.

Two handwheels were used for the control, one for the reversing and the other for the starting operations, both being positively interlocked. The second wheel controlled also the speed of the engine.

Attached to the engine was the vertical cooling water pump plant consisting of three independent cylinders disposed on the front end of the engine on a steel framing. The center pump furnished sea water for the lower heads and the liners, the wing pumps fresh water for pistons and rods, shield rings and upper heads. Attached to these pumps were two lubricating and cooling oil-pumps for the force feed system. Cooling water was delivered to the pistons and rods through swivel joined pipes.

Attaching the pumps to the main engine is now a thing of the past superseded by electric drive. Coupled to and placed ahead of the engine was the scavenging plant which consisted of three double acting blowing cylinders of common design.

The engine including the scavenge pump, the two air-compressors, the air-bottles, water, oil and scavenge-air coolers, the water and the lubricating oil pumps weighed 1,230,000 lbs. Thus the complete plant weighed 112.5 lbs. per b.h.p.

The following data will be of interest.

	Main Engine	Compressor
Height above center line of crankshaft	20'-10 3/16"	10'6"
Height overall	23'-4 3/8"	12' 9 1/2"
Length overall from coupling flange to end of scavenger...	73'	
Length from fly-wheel to end of governor		19' 8 3/8"
Width overall	14' 9"	
Piston thrust at 568# max. pressure....	500,000 lbs.	
Piston speed	929 ft/min.	
Piston speed, maximum	1,458 ft/min.	
Circulating water, fresh water	1,635 gal/min.	
Circulating water, salt water	2,080 gal/min.	

These remarks may conclude the short outline of the history of the largest Diesel engine ever built. It is well-known, that

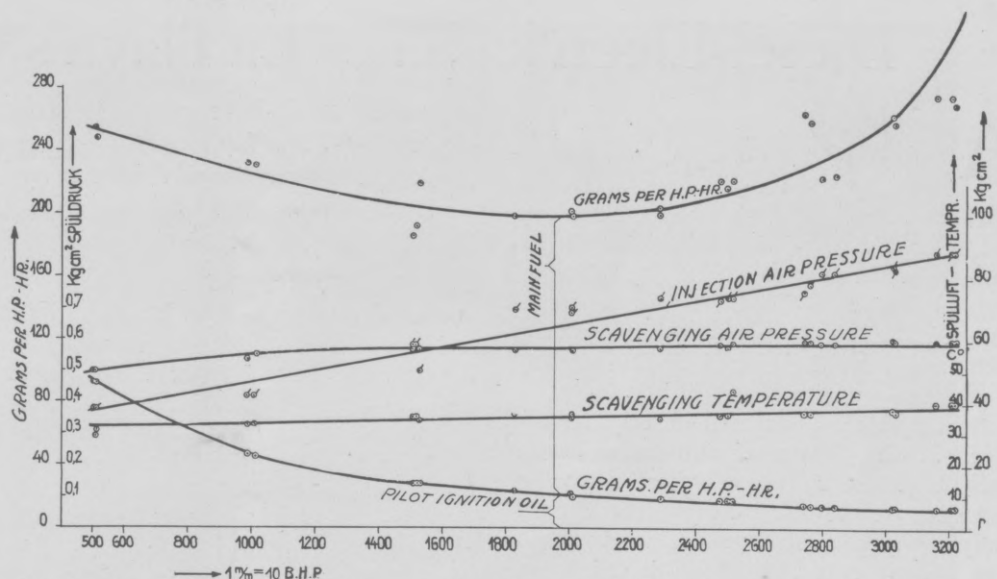


Fig. 9. Note how the fuel consumption (upper curve) increased rapidly as overload was applied with limiting amount of air

the engine had to be destroyed by order of the Allied Commission. There was, anyhow, little hope to use it aboard of a commercial vessel, because new construction at present is limited to moderately powered ships of 15,000—20,000 tons with scant chance that giant vessels of the pre-war type will be produced for some time.

The never-ceasing progress of oil-engine development has left this engine behind. Port scavenging has come into its own with the M.A.N. just bringing out a new scavenging method by which fuel and lubricating-oil consumptions closely approaching those of the four-cycle engine have been obtained.

Finis

American Dredging Company's Tug Runs Trials

New Boat Propelled by Winton Diesel Engine Adds to List of Vessels In Service With This Make of Engine

So numerous are the oil-engined tugs recently placed in service or now building, that we can hardly find room to deal with them individually when they run trials. One of the latest vessels is the ARTHUR N. HERRON just completed by the New York Shipbuilding Corp. for the American Dredging Co., of Philadelphia, and propelled by a four-cycle type eight-cylinder Winton Diesel engine of 500 s.h.p. at 250 r.p.m. The cylinders are 12 15/16 in. diameter by 18 in. stroke.

On trials the displacement of this boat was 312 tons on a mean draft of 10 ft. 2 in. with 20 in. drag aft. A speed of 9.8 knots was averaged through ice about 3 in. thick and against a weak tide. The engine turned at 248 r.p.m. and gave an output of 617 i.h.p. or 494 s.h.p. It drives a four-bladed solid propeller 7 ft. diameter by 4 ft. 3 in. pitch.

This vessel is 100 ft. long o.a., 89 ft. b.p. with 23 ft. breadth and 12 ft. moulded depth. The hull is built of steel with wooden fenders. She will be used for towing dredges and scows. Tank capacity is

provided for 18,000 gallons of fuel in three tanks, and provision is made for 6,000 gallons of fresh water. For auxiliary power there is a 20 k.w. Winton Diesel-driven generating set and a 5 k.w. gasoline driven emergency generator. Her steering gear and salvage pumps are electrically driven.



This new motor tug *Arthur N. Herron* has just run trials on the Delaware

Purifying Heavy Fuel-Oil

Last month we referred to the fact that for the purpose of removing ash and water content from boiler oil used as Diesel fuel, Furness-Withy's new 10,000 tons motorship PACIFIC SHIPPER would be equipped with centrifugal separating machines. Two electrically driven sets will be installed, each running at 6,000 r.p.m. and having a capacity of about 2,000 gallons per hour. One of these sets will also be used for purifying the lubricating oil and will be requisitioned for fuel oil only in case of emergency.

Diesel-Electric Ship La Playa's Maiden Voyage

AFTER a stormy passage the new motorship LA PLAYA, in command of Captain W. J. Close, arrived at Boston on February 14th. Her maiden voyage and arrival has been looked forward to with considerable eagerness by shipping men, as she is the first of three Diesel electric-propelled fruit-carriers built by Cammell Lairds for the United Fruit Company, of Boston.

A completely illustrated description was given in our November and December issues, together with comparison drawings and data on the sister turbo-electric fruit-carrying ship SAN BENITO, in which it was shown that the Diesel-driven vessel carries 29 per cent more cargo on a consumption of one-third the fuel-oil, with practically the same overall dimensions.

As may be expected, the results of this ship in service will have considerable bearing to the future of electric drive for cargo ships, as not only has she high-speed type Cammellaird-Fullager Diesel engines, but adding to the importance is the fact that it has been demonstrated under operating conditions that the turbo-electric drive is not economical, and it has been hoped that the much higher efficiency of oil-engines would enable the electric power transmission to be used with success.

The LA PLAYA left Liverpool on February 2nd, and on the voyage over encountered

*Averages 10.5 Knots Across Atlantic
on 12¾ Tons Oil Per Day—Speed
Actually Averaged Under Way
Was 11.34 Knots*

ered heavy gales and rough seas, which caused Captain Close to lay her to for 22 hours. The actual time at sea was 12 days, 2 hours and 4 minutes, or 290 hours and 4 minutes, and the ship was under way for 268 hours. As she logged 3,041 sea miles this gives an average speed for the voyage of 10.5 knots, and for the time under way an average of 11.34 knots. The best day's run was averaged at 13.1 knots. Considering the exceptionally bad weather and the fact that this was her first voyage, her owners regard this as a very creditable showing.

Chief Engineer Ronald Crumlay stated that her Diesel engines ran without a hitch of any kind, and that he considered her machinery a perfect job.

The total fuel-consumption was 154 tons of 28 degree Beaumé fuel oil, and of this 142 tons were used for the main engines and 12 tons for the auxiliaries. The total consumption figures out to one ton for every 19.75 sea miles covered. As the vessel took on 380 tons before the start of the voyage, she had a large fuel reserve upon arriving at Boston.

The lubricating-oil consumption was

rather high, averaging 35 gallons per day, for all the machinery. It is probable that this will be cut down considerably when the engines have been well worked in.

The total power of the LA PLAYA's engine is rated at 3,300 b.h.p. According to the figures given the average engine power developed on this voyage was 2,259 b.h.p., and the average at the propeller shaft was 2,028 s.h.p. This is a loss of only 10.2% in transmission, or an efficiency of 89.8%. The highest power developed on the trip was 2,929 b.h.p., with 2,400 s.h.p. at the shaft. The engines were run at an average speed of 250 r.p.m. while the propellers averaged 86 r.p.m.

The average speed made on the maiden voyage was considerably below her designed speed of 14 knots when loaded, but evidently the very heavy weather was responsible for this, together with the owners' desire not to drive her until the engines had been thoroughly worked in.

Her engine room force consists of five engineers, eight oilers, one donkeyman and one storekeeper—a total of fifteen men. Of these two engineers and three oilers are required for the large refrigerating installation, which consists of three J. & E. Hall refrigerating machines, and four air coolers driven by seven 35 inch fans for supplying air to the fruit compartments.

Machinery of "Motor-Steamer" Dolius

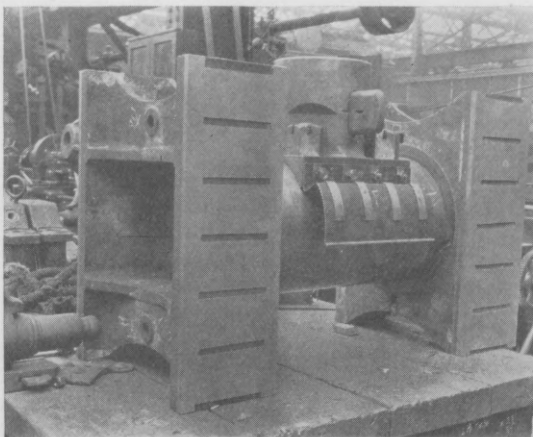
THE steam used in the four cylinders (of which one acts as H.P., the other as I.P. cylinder when running, and of which all act as H.P. cylinders when starting or maneuvering) is generated normally only from the waste heat of the combustion side. The exhaust gases on leaving the cylinder pass through a small steam generator (fitted with a nest of vertical water-tubes, 86 sq. ft. heating surface), one of which is attached to each cylinder. A lagged cast-iron pipe leads the gases from the generator to the lower firebox of a Yarrow type boiler, which firebox is equipped with a bank of cross tubes of 497 sq. ft. of heating surface.

There is one boiler for each engine, and both are situated at a higher level than the cylinder tops. From the boiler the gases pass through the feed-water heater (1,027 sq. ft. heating surface) and then to the stack. The engine circulating-water flowing from the water drum of the boiler to a junction piece, whence the pipe divides and leads the water through the small primary generators into the bottom of each cylinder jacket. The heat from the generator and the walls and head of the combustion-cylinder is absorbed by the water which now goes partially into steam; in which state it is collected into a common pipe and

*Continuation From Page 120 February
Issue of the Description of the
Two 1250 Shaft h. p. Scott-
Still Combination Steam
and Diesel Engines*

PART III

led to the top drum of the boiler where the entrained water separates out. Two oil burners fitted in the furnace front of the boiler are lit for raising steam initially (water-tube heating surface 882 sq. ft.). For maneuvering or overloads or such similar conditions, the steam supply can be augmented by fuel-oil burners under the boiler.



A dismantled crosshead of the Scott-Still engine

An exhaust-steam separator is fitted between the engine and the exhaust steam turbo-blower in order to prevent lubricating oil getting into the condenser. In addition the feed-water from the hot-well is pumped through duplicate oil filters.

It is interesting to note that the following auxiliaries are driven off the forward end flange of the crankshaft—

Boiler feed pump.....2" bore x 7" stroke
Boiler filter pump.....7" bore x 7" stroke
Forced lubricating pump (D. A.), 4¾" bore x 7" stroke.
Oil separator drain pump, 3½" bore x 3¼" stroke.
Condenser air pump.....14" bore x 15" stroke
Bilge pump.....6.3" bore x 7" stroke

Additional auxiliary equipment is as follows—

One 1,000 sq. ft. marine surface-type condenser (for both engines).
One electrically driven centrifugal pump (for both engines).
One pump for fuel oil burner equipment (steam driven).

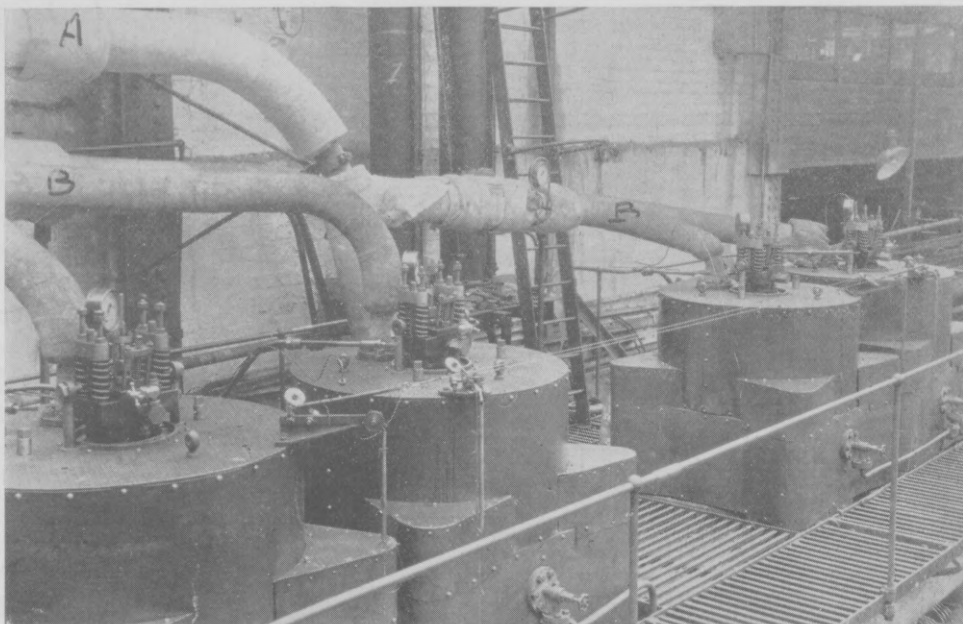
As standby gear certain equipment has been added which comprises—

Motor-driven Hele-Shaw Variable delivery oil pump (previously mentioned).
Steam-driven Weir feed pump.
Steam-driven forced lubrication pump, and evaporator.

In addition to the oil-engine driven generating sets there are the usual ship auxiliaries—and this type of installation permits them to be steam or oil engine driven as desired.

As steam is used for starting, the installation does not require the usual equipment of auxiliary air-compressors and their various accessories, although a small steam-driven compressor is available for starting the small 10 k.w. hot-bulb emergency lighting set or any of the three electric generators should all the air have been lost by some reason or other.

Each engine is a four-cylinder unit with cylinder dimension of 22 in. bore and 36 in. stroke. The normal rating, operating as a combined two-stroke-cycle oil engine and single-acting steam engine, is 1,250 s.h.p. at 120 revs. per min. This is equivalent to 75 lb. per sq. in. mean-effective pressure, or slightly over 87 lbs. per sq. in. mean-indicated pressure with a mechanical-efficiency of 86 per cent. As the m.i.p. on the oil side is around 79 lbs. per sq. in., about 8 lbs. per sq. in. (referred to area of oil-fired cylinder) is acting on the steam side. This pressure is that of two expansions only, the third not appearing as indicated power, because it is used for driving the scavenge turbo-blower in the L.P. turbine with an exhaust of about 28 in. vacuum. Nearly all the power on the oil side is, therefore, transmitted in full to the propeller, because the power on the steam side (i. e. about 10% of the oil-cylinder power) is adequate to overcome the frictional and other incidental losses. This



Lagged cylinder heads of the Scott-Still engine

steam is generated by the heat otherwise lost during the ordinary combustion cycle, and hence furnishes a net gain for the Scott-Still principle.

During the trials the engines ran with every satisfaction and demonstrated their great flexibility in speed range. With oil burners in operation the engine can run continuously as a single-acting steam engine at about 20 revs. per min. as a minimum speed. Firing on the oil side becomes possible at

30 revs. per min. and various combinations of oil and steam power give a speed range between 20 and 135 revs. per min.

Everyone will follow with great interest the behavior of this type of engine at sea. But, as yet no concerns in the United States have shown a strong inclination to adopt this combined steam and "Diesel" design of oil engine. If benefits are proved in actual service another story may be told in this connection.

Why Our February Issue Was Late

Readers received the February issue of MOTORSHIP about two weeks late last month. This was due to the fact that paper for MOTORSHIP being of large size and good quality has to be especially made. A carload of paper from the mill got lost somewhere in the snowbound railroads of Maine. After considerable delay we managed to secure paper of the right size from another source and the issue was printed. This, of course, also resulted in this March issue being about a week late, but we hope to catch-up and come out on time with the April number.

Will Convert Two Steamers to Diesel Power

For the purpose of purchasing United States Shipping Board steamers and converting them at American yards to American Diesel power a new business organization has been formed, known as the Diesel Steamship Company, 24 Stone St., New York City. An excellent start has been made by the acquisition of the WAUKESHA, built in 1918 by the Pusey & Jones Co. of Wilmington, Delaware. She measures 298 ft. in length, has a depth of 10 ft., beam 44 ft., and carries 3900 deadweight tons.

Mr. Nolan of the company advised us that the machinery is ordered. The Diesel engine which is to replace the geared-turbine drive originally fitted is already built and waiting for shipment. It was built by the McIntosh & Seymour Corporation of Auburn, N. Y., and was de-

scribed in outline in MOTORSHIP for November, 1923. Stroke and bore dimensions are 28 in. by 48 in. and 2,250 i.h.p. are developed in six cylinders at a speed of 115 r.p.m. It is the maker's most recent Diesel design, so should make the WAUKESHA a notable addition to the American motorship fleet.

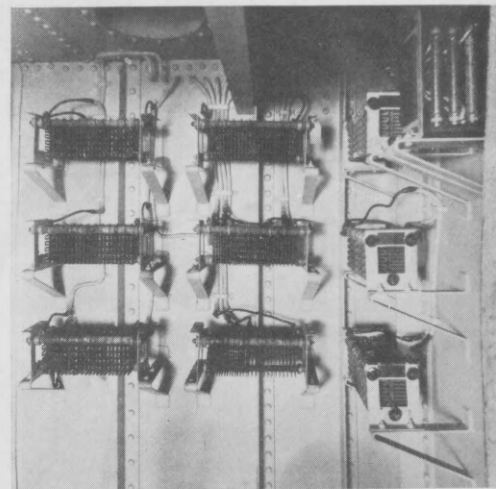
The Diesel Steamship Co., we understand, is also purchasing the Shipping Board's geared-turbine steamer OZAUKEE, built in 1918 at Long Beach, Cal. This is a 6,000-ton vessel measuring 341 ft. x 48 ft. x 27 ft., and her conversion to Diesel power will also be undertaken shortly.

The Motor-Liner for Netherland S. S. Company

Last month we referred to the Netherland Steamship Company having placed an order for a 14,000 gross tons passenger motorship with a French shipyard. We are now enabled to give further details. The contract has gone to the Ateliers & Chantiers de la Loire of St. Nazaire. The hull is of 22,000 tons displacement and 16,000 tons gross, and not 14,000 tons as previously stated. The length of the vessel is 540 ft. overall, by 520 ft. b.p., 67 ft. breadth and 38 ft. 6 in. depth and 28 ft. draft.

As previously stated, twin eight-cylinder, Sulzer two-cycle type Diesel engine of 5,200 i.h.p. or 4,000 s.h.p. each at 100 r.p.m. are being installed. Incidentally, this is the first time that *eight-cylinder* two-cycle Diesel engines of high power have been adopted. They are the largest single-acting

type Diesel marine engines which have ever been ordered, although there are Sulzer six-cylinder engines of 4,000 b.h.p. at 150 r.p.m. in service on land. Scavenging air will be supplied by independent electrically driven turbo blowers, which is now becoming standard Sulzer practice. In addition to the main engines there will be auxiliary Diesel engines aggregating 2,000 i.h.p., so the total power of the ship will be 12,400 i.h.p. Both the main engines and auxiliaries will be constructed at Sulzer Bros. Winterthur Works in Switzerland, where is also being built the 4,800 i.h.p. six-cylinder, two-cycle Diesel engine which is to be installed in the passenger steamer BINTANG, now being converted for the same owners.



Westinghouse grid resistors on m.s. *Seekonk* are mounted in water-tight deck housing and are fully accessible. See page 183

Motorship

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Published Monthly in the Interests of Commercial and Naval Motor Vessels and
for Recording International Progress of the Marine
Heavy-oil Internal-Combustion Engine

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The Comparative Value of Diesel and Steam Powers.

RECENTLY the Shipping Board refused a bid from the Roosevelt Steamship Co. of \$606,000 for the 12,375 tons d.w. 8,168 gross tons motorship WILLIAM PENN. At the same time they turned down a bid of \$567,000 for this vessel from the Barber Steamship Co., who at the present time are operating the ship and are guaranteeing the Board \$100,000 per annum. The higher bid works out at about \$49 per deadweight ton, and a little over \$74 per gross ton, respectively. For most of its cargo steamers the Board has set a price of \$30 per d.w.ton.

Several weeks later the Board announced that it had sold the seven 502 ft. combination passenger-cargo ships of the PRESIDENT Class to the Dollar Steamship Company for \$3,850,000 (\$550,000 each) or for \$42.14 per d.w.ton. (\$52.22 per gross ton). In other words, the Board is virtually admitting that an old war-time built motor freighter is worth more today than high-grade steam-driven liners of much higher speed and greater overall length, equipped with excellent passenger accommodation. While this certainly is one of the greatest compliments the Board could pay to the value of oil-engine power as a propulsive medium, had the farseeing policy of chairmen like Wm. Denman been followed during the Board's constructional program, a much larger portion of our fleet would be on the high seas to-day sharing in the world's commerce like the WILLIAM PENN, instead of rusting in our harbors and forming a menace to the country's entire merchant marine industry.

Lloyds Recent Figures

BY a series of quarterly, half yearly and yearly reports, Lloyds Register of Shipping endeavors to keep the shipping world informed as to the condition of the shipbuilding industry. Last year, says Lloyds, 1,643,181 tons of ships were launched, compared with 3,332,000 gross tons for 1913, which was the last pre-war year. In other words, less than half the tonnage took the water. The United States showed a slight gain but Great Britain made a drop of nearly 20 percent. What is pregnant with significance is Lloyds statement that an increase was shown in 1923 in the construction of motorships which totals 226,000 tons actually launched during 1923. In contrast with the gain in motorship construction, continues Lloyds, a marked decline was shown in the construction of vessels with turbines. Consequently, the 1922 lead of the turbine over the motorship of 900,000 tons was cut to less than 100,000 tons. These comments of Lloyds clearly indicate that the motorship has arrived to stay. Just prior to the beginning of the war, motorships only represented 2.7 percent of the World's ton-

nage. To-day 35 percent of the merchant craft now building are Diesel powered, or 634,000 gross tons compared with 1,793,500 tons of steamers.

An Object Lesson to American Shipyards

WITH few well-known exceptions little encouragement has been given in the past to Diesel engine adoption and development by our shipyards. Even to-day there are plants doing absolutely nothing in this direction except marking time, or putting an occasional clog in the wheel of progress. An object lesson to such shipbuilders is to be found in the January 1st, 1924, number of the SCANDINAVIAN SHIPPING GAZETTE. This journal points out that big Norwegian shipbuilding orders are going to Germany, Holland and Denmark partly because these vessels are being equipped with Diesel motors, the Norwegian yards for the most part not having facilities for motorship construction, although the Akers yard, at Kristiania, is planning a new Diesel plant. Diesel motorship contracts recently placed outside of Norway by Norwegian shipping interests consist of 28 craft aggregating 233,700 tons deadweight, or a total European value of about \$14,400,000. These orders are as follows:

Shipowner	Builder	No. of ships	Tonnage per vessel
Wilhelm Wilhelmsen, Tonsberg.....	Deutsche Werft.....	7	6,500
Wilhelm Wilhelmsen, Tonsberg.....	Deutsche Werft.....	3	10,000
Wilhelm Wilhelmsen, Tonsberg.....	Chartiers St. Nazaire	2	10,000
Ivar An. Christensen.....	Burmeister & Wain..	2	7,600
Bergenske S. S. Co., Bergen.....	Burmeister & Wain..	1	6,800
Knut Knutsen, Haugesund.....	Netherlands S. B. Co..	2	12,800
Laurit Kloster, Bergen.....	Burmeister & Wain..	2	6,500
Gunnor Knudsen, Porsgrund.....	Burmeister & Wain..	1	6,000
Gunnor Knudsen, Porsgrund.....	Burmeister & Wain..	2	8,000
Westfal Larsen, Bergen.....	Nakskov Shipyard ..	2	13,000
Fearnley & Eger, Kristiania.....	Deutsche Werft.....	2	7,500
A/S Borgestad.....	Burmeister & Wain..	1	8,000
A/S Borgestad.....	Burmeister & Wain..	1	6,600
Total..... 28 ships, 233,700 tons deadweight			

In this list are not included several additional motorships ordered two or three years ago by Wilhelmsen from Burmeister & Wain and already in service. But, the above should be sufficient to give our own shipbuilders plenty of food for thought, especially when we realize that last year many Diesel-driven vessels of good size were ordered by American shipowners from Europe.

The Line 'Twixt Ultra-Conservatism and Progress

SO rapid is the march of progress in modern times that when one is not steadily moving ahead it is a case of going astern. Let us hope that this is not the path being followed by the Southern Pacific Steamship Company. This well-known coastwise operating concern is now preparing to accept bids on its second *steamship* within six months—a vessel of 7,950 tons deadweight and 14¾ knots speed, which is to have reduction-gearred turbines of about 5,000 horsepower. The company is fortunate in that it does not have to meet foreign competition, otherwise the economy of oil-engine power would have to be given more serious consideration. Doubt in the Diesel engine's ability to reliably run on heavy Mexican fuel seems to be the deciding factor for turbine adoption. Executive and technical conclusions on power problems, of course, naturally differ. But, so forcible are the successes of Diesel ships operating on heavy oils, that the observer might ask if over-cautiousness and lack of the progressive spirit or bold enterprise which have made merchant marines, weighed more heavily in this decision.

An Eminent Consultant and Diesel Progress

RECENTLY Sir. J. Fortescue Flannery, the well-known British consulting engineer, was elected president of the Institute of Marine Engineers. In his presidential ad-

dress before the Junior Institution of Engineers, Sir Fortescue reviews marine propulsion during 50 years under that heading. A considerable proportion of this address is devoted to a resume of Diesel-engine progress, incorporating direct drive, reduction-gear drive and electric drive. But, Sir Fortescue does not appear to be acquainted with what has been done in the way of oil-engine development in the United States during the last few years, as no reference is made in this 50 years' review to any of the important designs of engines which have been produced in this country, although he freely discusses the leading British types. The development of the oil-engine is international, however, and not restricted to Great Britain.

"I express the regret," says Sir Fortescue, "of all British engineers, that the name of Dr. Diesel should appear to be permanently associated with that type of internal-combustion engine which derives its motive power from ignition by compression-generated heat of the explosive mixture of air and petroleum gas. It has been claimed, and the records of British Institutions seem to prove, that the first and true inventor was a British engineer living in Western Australia, who never seems to have had the chance to advocate his invention with sufficient publicity, nor to identify his name with it."

He considers the use of gearing the least attractive of all methods of reducing the high speed of the engine-shaft down to the relatively slow speed of the propeller-shaft, on the grounds that gearing is at best a complication not only in the first cost, but in use and maintenance and in liability to accident at sea. To substantiate his remarks he refers to his own personal experience with the first use of gearing at sea with a steamer so equipped 40 years ago. No reference is made by him to the results of the most interesting and extended developments made during the last several years with gearing in conjunction with oil-engines by the Falk Corporation of Milwaukee, or by Blohm & Voss, and the Vulcan Co. of Hamburg.

Apparently Sir Fortescue holds the opinion held by many others that the ultimate development of the oil-engine is the double-acting two cycle design. He mentions that considerable progress has been made with electric-drive in the United States, but does not quote any definite installations and confines himself exclusively to recent installations along these lines carried out by British engineers as being greater engineering advances.

It must be said, however, this notable consulting-engineer unhesitatingly points out that the savings effected by Diesel power largely outweigh the extra first cost, and quotes as an example that a vessel of 9,000 tons d. w. would

cost £25,000 (\$112,500) more than a steamer, but would show an annual saving on fuel alone of £10,645 (\$37,902.50) or a return of over 42 percent on the additional capital invested.

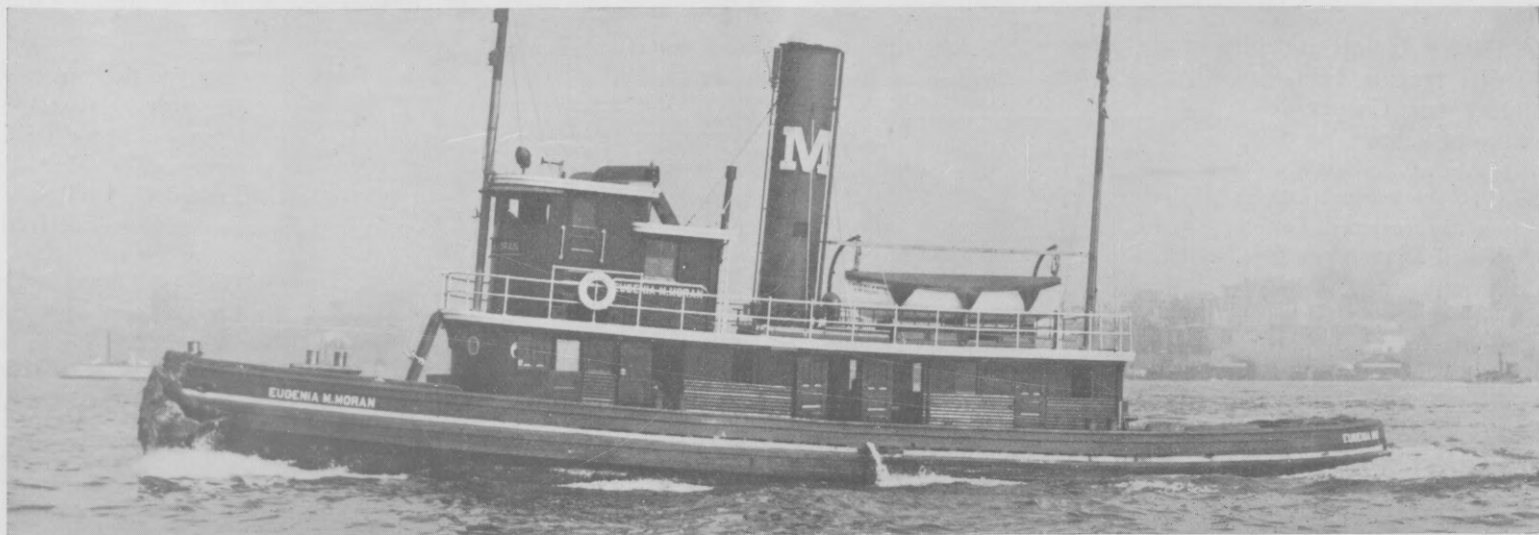
One other important matter, to which Sir Fortescue draws attention is the inadequacy of the present law of tonnage measurement as laid down by the British Board of Trade, and which appears to be universally adopted. This is based on the assumption that if the machinery space is 30 percent of the whole measurement capacity of the ship, there shall, in addition be allowed off the gross tonnage, 19 percent for storage of fuel. He echoes our previous urging that an amendment to this ruling is required so as to do justice to the motorships and aid in their development. The Board of Trade, he continues, should without delay, appoint a committee to take evidence and make suitable recommendations, so as to do justice to the shipowners and shipbuilders and the harbour authorities in the matter of proportionate allowance of registered tonnage.

Three 10,000 tons Tankers to be Converted

A CONTRACT now pending, and which probably will be signed before this appears in print, covers the conversion to Diesel power of the Standard Oil Company's three steam-tankers TRONTOLITE, JOSIAH MACY and S. B. HARKNESS. This conversion portrays in a striking manner the coming change in machinery for large vessels of all types. These tankers are craft of about 10,000 tons d. w. and at present are equipped with turbines and reduction-gears, so may be considered as quite modern vessels. They now will be converted to single-screw Diesel-driven vessels.

Unfortunately for the American shipbuilding and Diesel engine industries, a foreign company will receive the order, due in the main to the much lower prices which can be secured from abroad today. Lately the Standard Oil Co. of N. J. has been very active with its Diesel ship construction, its German subsidiary having ordered four vessels aggregating 50,470 tons d. w. and 11,700 shaft horsepower. The Standard Oil Co. of N. J. also recently took delivery of a small Diesel-electric tanker; the Standard Transportation Co. ordered nine Diesel and Diesel-electric tankers, and the Standard Oil Co. of Cal. have two such craft in service and are figuring upon converting some larger craft of their fleet.

Lack of adequate support to our merchant marine given by Congress seems to be the principal reason for conversions of the three above vessels being carried out abroad and operated under foreign flags. It is to be hoped that Congress will soon awaken to the vital needs of our marine.



This is the handiest and most economical tug in the big fleet of the Moran Towing & Transportation Co., of New York, and her oil engine is kept working twice round the clock every day, making a better showing than any steam engine. A shipowner can always rely upon prompt service

Interesting Notes and News From Everywhere

IN A tanker of 15,000 tons d.w., two 1,350 s.h.p. Armstrong-Sulzer Diesel engines will be installed.

Reinforcing the shrunk-on portions of built-up crankshafts by welding is being tried out in Great Britain.

Two Bolinder oil-engined self-propelled hopper-dredges have been ordered by the London & North Eastern Railway Co., England.

Mr. R. P. McLennan of the Royal Vancouver Yacht Club is having a 40 b.h.p. Atlas-Imperial oil-engine installed in his cruiser *MIAWA*.

The Hon. Geo. C. Crellin has ordered a 233 tons motor-yacht on the *CLYDE*. Twin 200 s.h.p. Gardner surface-ignition oil-engines will be installed.

The Standard Oil Co. of N. J. will convert its three 10,000 tons steamers *TRONTOLITE*, *JOSIAH MACY* and *S. B. HARKNESS* to single-screw Diesel power. See page 193.

A 1,800 s.h.p. Sulzer-type Diesel engine has been built by the Wallsend Slipway & Engineering Company. Wallsend-on-Tyne for an 8,000 tons single-screw motorship.

CROWLY No. 20, a new towboat powered with a 250 b.h.p. Pacific-Werkspoor engine has just run trials. Another similarly equipped tug is now building.

In the 73 ft. passenger boat *MARINE EXPRESS* owned by the Marine Navigation & Engineering Co., of Vancouver a 108 b.h.p. Vickers-Petters oil-engine will be installed.

Work on hand at the Rotterdam Dry Dock Co., Rotterdam, includes a Diesel-driven tanker of 11,100 tons d.w. being equipped with a Harland-B. & W. Diesel engine of 1,850 shaft h.p.

A 110 h.p. Union oil-engine of the airless-injection type is being installed in a tug building for Cooper & Smith of New Westminster, B. C. This engine is of the same power as recently ordered for the Powell River Co.'s 6 ft. tug building at Menchions Shipyard, Vancouver.

It is with regrets that we recently learned of the death on February 14th of B. L. Knowles, Manager of the Publicity Department of the Worthington Pump &

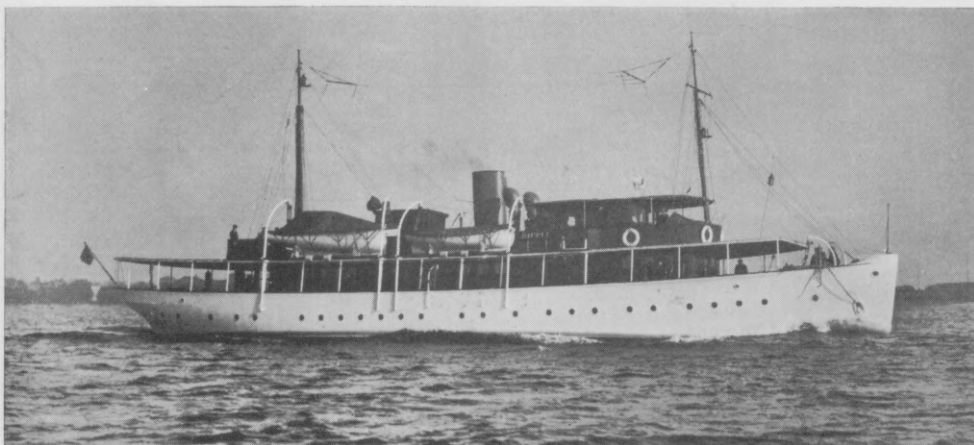
World's Record of New Construction, Ships Performances and Other Matters of Note in the Motor-Vessel and Oil Engine Industries



The beautiful auxiliary yacht *Moby Dick* owned by F. S. Fish, of New York, and powered with a 180 s.h.p. Krupp Diesel engine

Machinery Corp., New York, as the result of a cerebral hemorrhage. Although only 45 years old he had spent 28 years with the Worthington Pump Corp.

Lloyd's figures of mid-1923 showed that more two-cycle than four-cycle Diesel engined ships were building. Today of 175 large motorships on order 79 have four cycle single-acting Diesels, 91 two-cycle single-acting, four with four-cycle double-acting, and one with a double-acting two-cycle set. Recent orders have changed this to four-cycle lead. By June next it is possible that the position will have again changed in favor of the two-cycle.



The 133 ft. motor yacht *Ripple* owned by C. M. Leonard of Chicago, and equipped with twin 250 s.h.p. Krupp Diesel engines

The total contract price signed by the Bank Line with Harland & Wolff for the construction of the barge fleet of motorships previously referred to was \$7,700,000 (\$8,700,000 gold standard) or at approximately \$50 per d.w. ton. On February 12th last the Commissioners of the British Treasury agreed to guarantee an issue of \$7,750,000, 5 per cent, of the Debenture Stock (1928 to 1944) at \$430 per share, at an issue price of \$423, or 98½ per cent. The subscription list was opened on February 20th and closed the following day oversubscribed.

Five Kromhout surface-ignition oil-engines have been sold in Canada since the beginning of the year. Two are for a steel automobile ferry of 35 car capacity for the St. Lawrence River at Lachine, Quebec; two are for a Quebec pulp and paper company's supply boat; and one is for a fishing boat at Louisburg, N. S.,—state the Crude Oil Engine Co., of Montreal.

Following the recent controversy in Holland over the Netherland Steamship Company having ordered a large motor-liner from the Chantiers de la Loire, of France, the same owners are reported to have ordered a 14,000 tons motorship from the Chantiers & Ateliers de Saint Nazaire, to be equipped with Burmeister & Wain type Diesel engines. We think this, however, must be confused with the order for two motorships ordered from the latter shipbuilding company by Wilhelm Wilhelmsen, of Tonsberg, Norway.

The hull of the Forestry cruiser built by the Forestry Branch of the Department of Lands of British Columbia has just been completed. She is a 57 footer, and a 50 b.h.p. Washington-Estep oil-engine is now being installed at Vancouver. This Department is also putting an oil-engine in the 49 ft. Forestry Protection launch *EUCLETAW*. This is a 54 b.h.p. Vickers-Petters unit. An engine of the same make, but of 28 b.h.p. has also been installed in the 36 ft. Forestry protection launch *COTTONWOOD*.

The French licensees for the Sulzer Diesel engine, namely the *Compagnie de Construction Meccanique Procedes Sulzer*, of Paris, have received an order for two Diesel engines of 2,200 s.h.p. each for the new motor passenger-liner for the *Services Contractuels de Messageries Maritimes*. The auxiliary Diesel engines will develop 1,300 b.h.p., so the total power of the same will be 3,500 s.h.p.

Lecturing before the Norwegian Engineers'



Installing a frame of one of the 500 h.p. McIntosh & Seymour Diesel engines into the wooden ship *Oregon*

Society and the Norwegian Shipowners Association, at which gathering were the Minister of Labor and various members of the Norwegian Parliament, Dr. Danchert Smith laid particular stress on the value of the Diesel engine for cargo ships. He pointed out the advantages of this type of power for small freighters on long voyages. He stated he would not hesitate to say that a motorship of 3,000 to 5,000 tons d.w. is one of the most profitable vessels one can offer an owner.

H. Hogarth & Son, a British concern, are the owners of the 6,000 tons d.w. motorship *BARON DALMENY*, in which a six-cylinder Cammellaird-Fullagar oil-engine of 18½ in. bore by 25 in. stroke built by David Rowan & Co., of Glasgow, has been installed. The hull builders, it will be recalled, are Wm. Hamilton & Co., Port Glasgow, Scotland.

Already possessing eleven ocean-going motorships, the Johnson North Star Line, of Stockholm, will shortly contract for two additional motorships of 6,500 tons d.w. each,

in addition to the 6,550 tons motorship now building at Malmo and being equipped with two Kockum-Augsburg four-cycle Diesel engines 1,100 s. h. p. each. The Kockums shipyard recently acquired an Augsburg license from the M. A. N.

Clifford M. Leonard's, of Chicago, new 135 ft. Diesel yacht *RIPPLE* arrived at Miami, February 7th, after a successful cruise to South America. It is only recently that this vessel crossed the Atlantic from her builders' yard during very heavy weather. This speaks well of her lines, which were designed by Cox & Stevens. Her recent trip to South America, through bad weather nearly all the time, was made on schedule time.

New designs are now being gotten-up by the Naval architect of the City of New York for Diesel-electric driven ferry vessels. These are new and additional boats, and will not take the place of the stream-propelled ferry boats for which specifications are now before the Board of Estimate.

American oil-engine manufacturers should send catalogues of oil-engines suitable for fishing boats to the Ministry of Agriculture of the Government of Latvia. The Ministry does not propose to buy oil-engines, but needs the catalogues for the purpose of recommending to fishing vessel owners.

To the order of a Norwegian shipowner a four-cylinder, 1,350 s.h.p. two-cycle Sulzer type Diesel engine has just been completed by Armstrong, Whitworth & Co., Newcastle-on-Tyne. She is a single-screw vessel of 3,500 tons gross. The engine will turn at 100 r.p.m. It is not widely known that Armstrong Whitworth & Co., are also building a twin-screw 10,000 tons d.w. Arm-

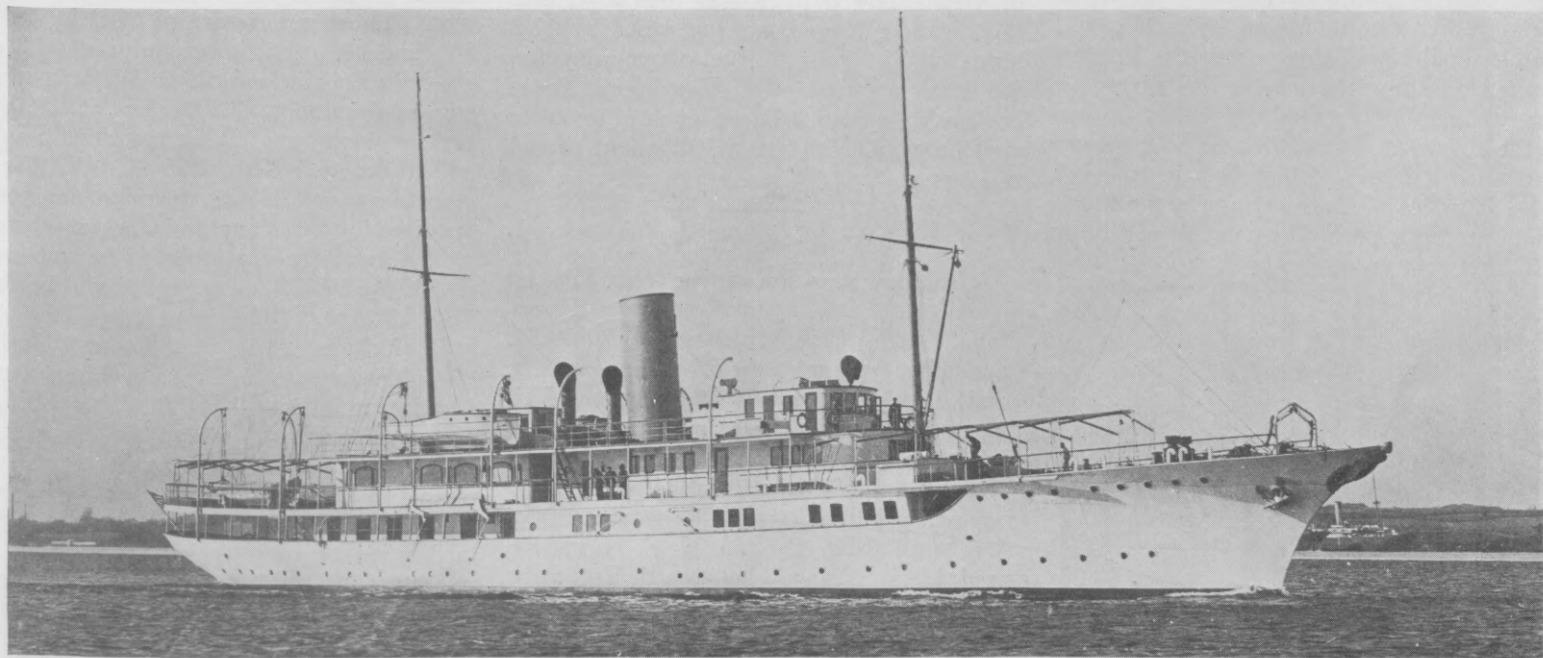


Auxiliary yacht *Dauntless* owned by W. M. Hanan, and powered with a Krupp Diesel engine

strong-Sulzer Diesel tanker to the order of Belgian owners.

On her recent trials the twin 900 s.h.p. Krupp Diesel engines drove C. K. G. Billings' new motor yacht *VANADIS* at a speed of over 14 knots. This vessel will shortly leave on a transocean voyage for the United States. Her fuel and store capacity is sufficient for a cruise of 12,000 miles. She will be a notable addition to the New York Yacht Club. She is equipped with a Sperry stabilizer.

C. A. Burckhardt of the Alaska Consolidated Canneries, recently decided to install twin McIntosh & Seymour 500 b.h.p. Diesel engines in the wooden vessel *OREGON*. A new organization has been formed in Alaska known as the Independent Steamship Company, with headquarters at Juno, who will operate this vessel in freight service between Seattle and south-west Alaskan points. The *OREGON* is 234 ft. long, 43½ ft. breadth and 23½ ft. depth, and is of 3,000 tons d.w. Her new machinery is expected to give her a speed of about 11 knots.



Vanadis, the beautiful 2,000 s.h.p. Diesel-driven motor-yacht built at Krupps in Germany, for C. K. G. Billings, of the New York Yacht Club, from designs by Cox & Stevens. Length 240 ft., breadth 35 ft., draft 14 ft., speed 14 knots

Diesel Engines in a Small Tug Hull

The demands of economy in the towing business led H. Bruno of Vancouver, British Columbia, to install a Diesel engine in his 42 ft. tug PROSPECT POINT in place of a 30 h.p. distillate burning engine. He states that he did not wish to get a bigger boat requiring a crew of more than two men to operate; and while his 30 h.p. gasoline engine had been doing excellent work the cost of fuel of the power that he required apparently would eat up too large a part of his earnings. The solution of his difficulty was found in a three cylinder Wolverine oil engine developing 70 b.h.p. at 350 r.p.m., and equipped with a reversing clutch.

The PROSPECT POINT is 42 ft. o.a., 10 ft. 11 in. beam and 5 ft. 1 in. moulded depth; and though 70 h.p. could hardly be utilized to advantage in this form and size of hull, running light, it does practically the same work in smooth water as it would in a larger hull when fast to a tow of logs moving at $1\frac{1}{2}$ to 2 knots. Log towing is a large part of the work of the harbour tow-boat at Vancouver; and fir, cedar, spruce and hemlock logs of three to six ft. diameter and thirty to fifty ft. long are heavy tows. They are made up in sections which frequently scale 40,000 feet or more, board measure. Booms of 10 to 15 sections are frequently handled into and around the harbour by the smaller class of harbour tugs.

The first propeller tried out on this boat had a diameter of 44 in. and pitch of 36 in.; and running light on her trials with the engine turning at 350 r.p.m. an average speed of 9.25 knots was maintained.

While this wheel would probably be very effective towing scows or barges it was found to have too much pitch for a heavy log tow and slowed the engine down about a hundred revolutions. The pitch was then altered to 30 inches which enabled the engine to turn up 280 r.p.m. at normal speed on a heavy tow, and 320 when overloaded. Mr. Bruno contemplates trying out another propeller with 42 inch diameter and 28 inch pitch, which would probably allow the engine to turn up somewhere near 350 r.p.m. on log towing work. The fuel consumption of the PROSPECT POINT on a 28 hour steady pull with a boom of logs is said to have been 85 gallons, or an average of 3 gallons an hour, or a cost of 15 cents per hour with fuel at 5 cents per gallon.



British Columbia tug *Prospect Point* powered with a 70 b.h.p. Wolverine oil-engine

Norwegians Order Two Motorships in France

When in France last fall we learned from a prominent French Shipbuilding Company that they expected to secure a license to manufacture Diesel engines under Danish design. This was the Chantier et Ateliers de Saint Nazaire Penhoet, who then were negotiating with Burmeister & Wain, of Copenhagen. The license has been secured, and has been followed by a contract for two high-powered motorships to be equipped with engines of this design. Wilhelm Wilhelmsen, of Tonsberg, has placed a contract with this French Shipbuilding company for two motor-freighters, each to be equipped with twin 2,000 i.h.p. Burmeister & Wain Diesel engines. The hulls, 416 ft. long with 54 ft. breadth and 38 ft. depth, will be built at the Grand-Quevilly shipyard (near Rouen) of the St. Nazaire concern. But one pair of Diesel engines will be built at the St. Nazaire Company's Penhoet plant, while the other pair will be built by Burmeister & Wain, of Copenhagen.

Training Motorship for France

SECUNDUS, the first motorship which Blohm & Voss completed early in 1914 will probably be purchased by the Société Générale de Transports à Vapeur. This vessel is of 7,800 tons d.w., and is equipped with two Blohm & Voss, single-acting two-cycle type Diesel engines of 1,300 b.h.p. each. It is proposed to use her as a training vessel for engineers, and other French shipowners will have the privilege of sending engineers aboard on the voyages. These engines are of very early type, and it is possible that they may be replaced very shortly by another make of Diesel engine.

Motor Liner's Operation

Up to a recent date the combination passenger and cargo motor-liner DURENDA of the British India Steam Navigation Line had completed 26,950 nautical-miles with highly satisfactory results from every point of view. She is of 10,850 tons d.w., and the distance logged was averaged at 11.2 knots on 11.5 tons of fuel-oil per day for the main engines. Two 8-cylinder, four-cycle, North British Diesel engines together developing 4,660 i.h.p. at 96 r.p.m. propel this vessel.

Vacation Cruise

A summer vacation cruise from July 1st to August 31st, from Boston to Horta, Fayal, Azore and Funchal, Maderia, for men over seventeen years of age, will be made by the sailing ship "NEREUS." It is hoped that out of these cruises a Nautical School will grow, and it is expected that a Diesel Engine will be installed as an auxiliary part. Particulars can be obtained from Armistead Rust, Captain, U. S. Navy, Retired, U. S. S. Nantucket, North End Park, Boston 16, Mass.

Notes on New Oil-Engine Naval Craft

Japan will build sixteen 1,500-2,000

tons oil engined submarines under a recent authorization.

The second half of the French naval program calls for four 3,000 tons cruiser-submarines, and thirty of 1,300 tons, all with Diesel engines.

ADVENTURER, the British navy cruiser-minelayer, said to be propelled by Vickers Diesel engines, is nearing completion at Devonport dockyard.

"X.I," the world's largest submarine is about ready for service. She belongs to the British Navy, and was referred to in MOTORSHIP last year as building at Chatham Dockyard, where she was launched on June 16th, 1923. Her submerged displacement is 3,600 tons with 2,780 tons surface-displacement. Two (or three) Admiralty-built oil-engines of 3,000 shaft h.p. are installed. One British journal says she has enough power to drive her at 33-knots but we doubt it. She has six 5.5" guns. Her crew consists of 100 officers and men.

The Foresight of Ford

Every day from the coke ovens of Henry Ford's River Rouge big coke-ovens there are produced 4,500 gallons of refined light-oil, 18,000 gallons benzol, 17,800 gallons tar, 60,000 pounds of ammonium sulphate, 26,300,000 cubic-feet gas and 2,000 tons of coke. All these are by-products. Evidently Ford will have plenty of available fuel for his two 600 ft. motorships when completed, if their Diesel engines are arranged to burn tar-oil fuel.

The Bank Line Motorship Fleet

With reference to the order placed by Andrew Weir & Co., managers for the Bank Line, for 21 motorships as announced in MOTORSHIP for January, we understand the fleet will comprise vessels of two types; namely 7,000 tons D.W. single-screw and 10,000 D.W. twin-screw. Of the former, three vessels have now been launched as stated, including the GUJARAT and KATHIAWAR. These vessels are of 384' by 48' by 36', and are each to be equipped with one six-cylinder Harland B. & W. long-stroke engine, developing 1,650 s.h.p. at 85 to 90 revs. per min. and giving the ships a speed of 10 knots. Three 65 K. W. Diesel-electric generators are provided for power required by auxiliary and deck machinery.

The next three vessels to be put down are of the 10,000 ton type, and will be about 420 feet long. The main propelling plant will include two six-cylinder Harland B. & W. long-stroke Diesel engines together developing about 3,000 to 3,200 s.h.p. at the same engine speed as the single-screw ships. By retaining the same type of engine for the whole fleet it will be possible to take the fullest advantage of the standardization of construction, supervision and maintenance, and thus reduce their cost. The Government's loan for these ships is about \$8,500,000 for 20 years, under the Trade Facilities Act. The interest rate has not been made public.

Motor and Steam Have Tug-of-War

At Vancouver, British Columbia, the oil-engine tug ALMARA recently had a dynamometer test with the steam-tug SEA SWELL of about the same size and power; and the boats were further tried out by making them fast stern to stern and having a tug-of-war while the tug ANNACIS stood by acting as referee. The oil-engined boat pulled best on both tests; and though it must be stated in fairness to the steamer that she was being tried out to test the pull of a propeller that was not considered fully efficient for log towing; yet the test opened the eyes of a lot of steamboat men who had not previously realized that an oil-engine tug boat could develop her power so effectively on a standing pull. Otherwise the conditions if anything favored the steam engine turning up about 100 r.p.m., against a little over 200 r.p.m. for the oil engine with a 60" by 46" propeller.

The steam tug, SEA SWELL is a nearly new boat, and generally reported to be an efficient tow boat. She is about 86 feet o.a., her registered measurements being 75.7 ft. length b.p. and 19.9 ft. breadth. Her power plant consists of an oil-fired boiler carrying 165 lbs. steam pressure and a compound engine with cylinders of 10 in. and 22 in. bore respectively and 20 in. stroke; she swings a four-bladed propeller of 7 ft. 6 in. diameter and 7 ft. pitch, which is said to turn up about 105 r.p.m.

The engineer of the ALMARA states that on September 22nd the Ideal Iron Works sent down a dynamometer gauge to test the towing power of the steam tug SEA SWELL for which they had an order to make a new propeller. The SEA SWELL had taken about two hours to work up a good head of steam, and then warmed up her engines for twenty minutes alongside the dock. When the SEA SWELL was ready to pull out, the captain of the ALMARA asked his chief engineer if he would like to take a pull on the dynamometer too and see what oil-engines could do.

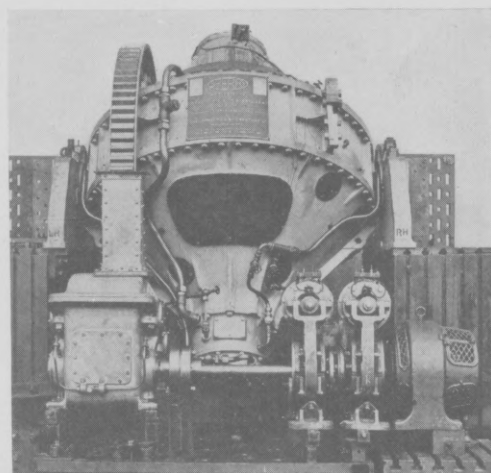
Without any preliminaries the ALMARA started up from cold and both boats proceeded to the Ballantyne Pier where a pennant from the dynamometer was secured to a cleat on the pier, the gauge being secured aboard the boat where a reading could be taken. First the SEA SWELL took a pull, and the reading on the dynamometer scale indicated a pull of 6,125 pounds. The ALMARA then hooked on and pulled 6,300 pounds with the engine controls set at her normal towing speed; then opening up her power to the fullest extent she registered a pull of 7,665 pounds.

The SEA SWELL was not satisfied with the showing on the scale, and asked for a tug of war; so both boats went out clear of the wharf, and were made fast stern to stern. The ALMARA began to tow the SEA SWELL; then much to the engineer's surprise the Captain of the ALMARA signalled him to stop the engines, giving the SEA SWELL a start. After gathering sternway the ALMARA was again started up, and towed the SEA SWELL after her.

Big Diesel Yacht for a Prince

Ramage & Ferguson, of Leith, Scotland, launched on Dec. 10 a twin-screw yacht of 800 tons Y. M. which they have designed and built to the order of H. H. Prince Youssouf Kamal. As this yacht will be one of the highest powered motor yachts afloat she will prove a notable addition to the ever increasing number of vessels which are fitted with Diesel engines instead of steam. The yacht, named NAZ PERWER, has been designed to attain a high speed and for making only voyages in the East. The dimensions are 235 ft. overall by 29 ft. 6 in. beam and 17 ft. depth.

The special feature of the yacht is the machinery, which consists of two sets of Sulzer Diesel engines each developing 850 S. H. P. These were made by Sulzer Brothers at their works in Winterthur, Switzerland.



Sperry-Gyroscope on the motor yacht *Vanadis*
Sperry Gyro for Big Yacht

VANADIS, C. K. G. Billings' 240 ft., 1,800 shaft h.p. Diesel-driven yacht now completing at Krupps, at Kiel Gaarden, Germany, is equipped with a Sperry Gyro stabilizer. The rotor is 87 in. diameter, weighs 13.5 tons, and is driven by an 80 h.p. 220 volt D.C., 1,400 r.p.m. spinning motor, the armature of which is mounted on the rotor shaft. The shaft bearings are designed to carry a load of 94,000 lbs., at an angular velocity of 0.765 radians per second, while the thrust load on the Michell thrust in 31,000 lbs., when the shaft is in a vertical position. The total weight of gyroscopic element on each gudgeon-bearing corresponds to 28,000 lbs., and the maximum stabilizing moment is 682,000 foot-pounds. The precession motor is operated from the same source of supply as the main rotor and develops 15 h.p. running at 650 r.p.m. The sea trials of this equipment have taken place.

George M. Marr, until recently District Manager in Philadelphia for Chas. Cory & Sons, Inc., has been transferred to the Sales Department in the main office in New York City. Robert L. Reaves will succeed Mr. Marr at Philadelphia.

Cubore's New Bethlehem Engine Demonstrated

SHIPOWNERS have not as yet come to regard as an everyday performance the effortless maneuvering and faultless initial operation of a newly installed 3,500-i.h.p. marine Diesel unit. Yet this is what was done on February 8th by the engineers of the Bethlehem Steel Company during the river trials of their newly installed 1924 model marine Diesel engine on board their motorship CUBORE. The revolution counter that went with this installation registered naught before any turning was done; just before the trial trip which we were privileged to witness it indicated a little over 400,000. Since the engine turns normally at about 100 r.p.m. it is easy to see that only the most routine kind of tuning-up had preceded the official trials.

By this we do not wish to imply that the Bethlehem Steel Company sprang full-

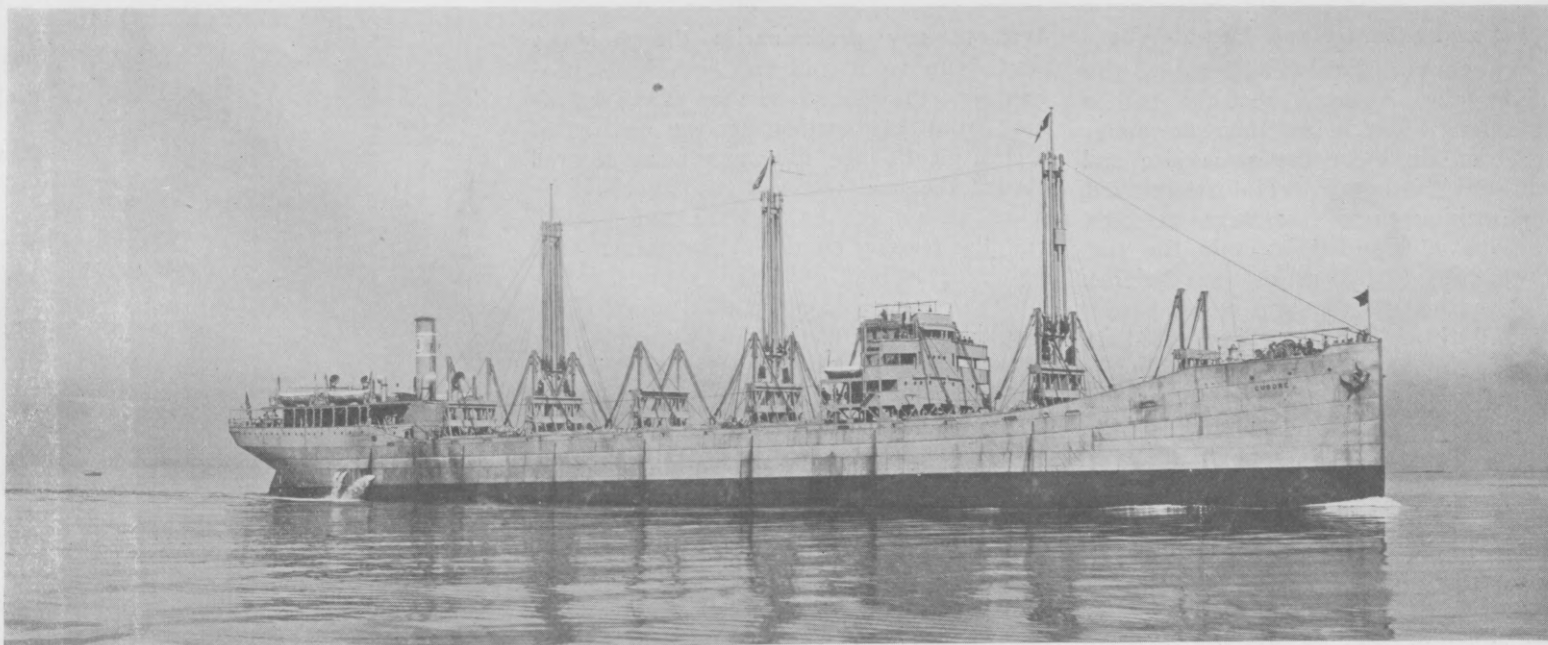
*Single-Screw Vessel of 3,500 i.h.p. is
Put Into Service by the Ore
Steamship Corporation*

grown from the head of Dr. Diesel and produced the CUBORE engine by a wave of her wand. On the contrary, this Diesel-engined vessel has seen service since 1920 and large double-acting gas engines have been built at Bethlehem for generations. The CUBORE has been doing regular duty for the Ore Steamship Corp., of New York as an ore-carrier between Sparrows Point and Cuba for a long period powered with a Diesel engine substantially similar to the one with which she is now equipped and in which are embodied modifications suggested by the operation of an exact duplicate in the Bethlehem power house. To all intents

and purposes it is a new unit, but at the same the finished product of years of varied experience on land and at sea.

The stationary engine, which has the same stroke, bore, and design characteristics as the CUBORE's propelling unit, has been illustrated on page 847 of MOTORSHIP for December, 1923, following a visit to South Bethlehem, Pa. We were impressed already at that time by the well-rounded features and finished appearance exhibited by the design, and found that the engine was capable of making protracted non-stop runs at full power without requiring anything more than the amount of attention which is considered a matter of routine in all oil engine plants.

That the application of the features developed on this engine to the CUBORE's machine did not involve any fundamentals is illustrated by the story of an emergency



Motorship *Cubore* on trial trip. This is Fig. 7 referred to in the article contributed to this issue by the Bethlehem Steel Co.

which occurred during one of the regular voyages of this vessel. More than usually thick and stormy weather lasting for several days without interruption had made it impossible for the commanding officer to get accurate bearings, with the result that the vessel grounded one night off Cape Hatteras. The shock was such that it threw the chief-engineer out of his bunk, but it was not sufficient to deprive him of his presence of mind. Running down the engine-room ladders in his pyjamas, he seized the manoeuvring controls and threw them from full-ahead to full-astern almost without waiting for the engine to stop. As he realized that everything was at stake, he did not hesitate to give her all that the fuel pumps would deliver, which was 40% more than normal. It did not take much running at this power to back the ship off the reef, and although twenty plates had to be renewed when she docked, her engines gave no evidence of hard usage.

As a motorship, the *CUBORE* is well up

among the big ones, as will be apparent from the following dimensions:

Length o. a.....	450' 0"
Deadweight	10,500 tons.
Power	3,500 i.h.p.
Number of engines.....	Single screw

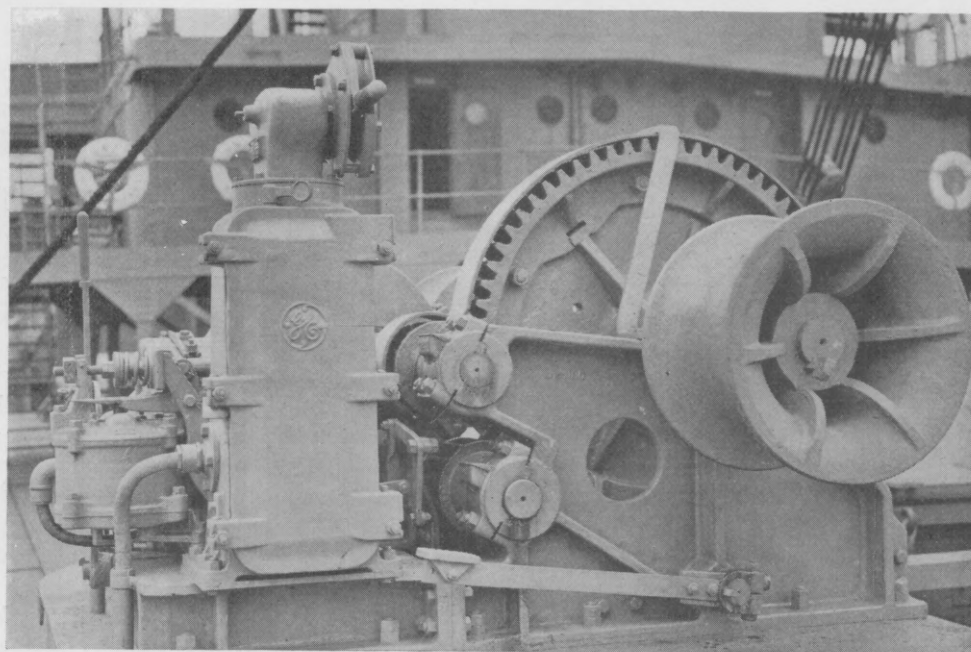
She was built several years ago at the Sparrows Point yard of the Bethlehem Shipbuilding Corporation, and has since been very fully equipped by the same firm. Although steam deck auxiliaries were originally fitted, she now has high-grade electric deck equipment consisting of winches, windlasses, and steering-engine designed and built at the Moore Plant of the Bethlehem Steel Company located at Elizabeth, New Jersey. They were installed at the time when the main Diesel engine, which has been developed into a regular manufacturing product, was put in place of the one that had been used in the development work. As a result, the decks have taken on a remarkably neat and business-like appearance, in strong contrast to those ships whose appearance and operating value are alike

impaired by jumbles of piping and lagging that obstruct their decks. The engine-room, of which more presently, has also been enormously improved by the elimination of the 16-ft. Scotch boiler and turbo-generator and by the substitution of a McIntosh & Seymour 150-b.h.p. Diesel engine direct connected to a General Electric 100-kw d.c. generator.

Two additional Diesel-electric generating-sets, exactly similar to the one just referred to, have been in the ship since she was first operated in 1920 and have given an excellent account of themselves. Steam is used for heating purposes only, but this too could be electrically eliminated at a worth-while saving; very precise measurements just made during the 13,000-mile voyage of the motorship *SECONK* described on another page show conclusively that heating, too, can be accomplished on a cargo-vessel by means of oil engine power with amazing economies.

Among the most notable auxiliaries are a 75-h.p. General Electric motor for the windlass, eight 50-h.p. of the same make for the mooring winches and six 25-h.p. motors for cargo-and-hatch winches. One generator only is required to supply this power except when the vessel is in port, loading or discharging cargo, when two Diesel dynamos carry the load. Their daily fuel consumption is a fraction of a ton, whereas equivalent steam machinery would require at least 10 tons a day.

All engine-room equipment on the "*CUBORE*" is of the most modern type. A Diehl motor with shaft extensions at both ends, drives Kinney pumps both for lubricating and fuel-oil required for the main engine. The unification of control thus effected (a General Electric automatic starting-controller is fitted) appeals strongly to the operating man, and is interesting also from the point of view of supplying fuel to the main engine. The fuel pump of the latter is located on the top platform, as will be more fully described in what follows. Being constantly connected to the fuel bunkers, the rotary pump begins to elevate fuel as



Close-up view of the new magnetic type of cargo-winch on the motorship *Cubore*

soon as preparations to get under way are started. The fuel reaches the engine pump under a head sufficient to eliminate all suction uncertainties and whatever excess there is simply returns to the bunkers. Daily service tanks are thus eliminated and engine room routine simplified.

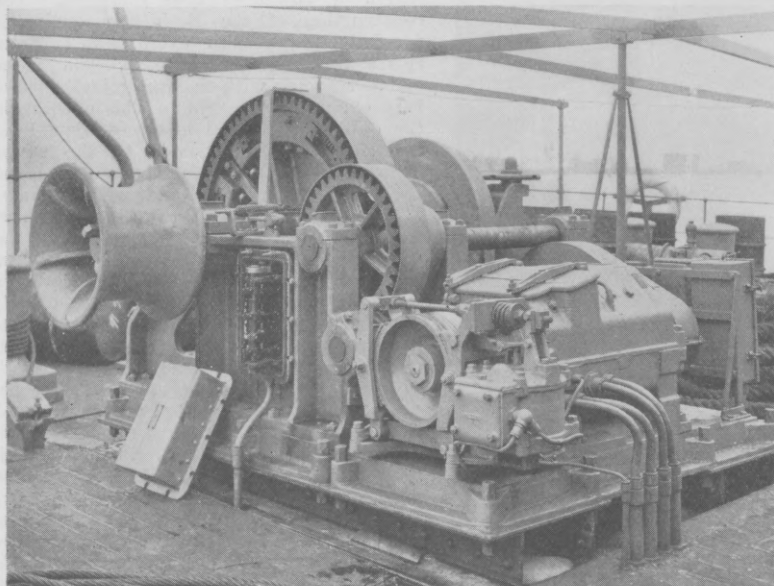
It might be argued that this method also prevents a check-up on the amount of fuel used. Everyone knows, however, that readings on daily service tanks, particularly in heavy weather, are far from being accurate and these readings are therefore quite generally checked against the well-known fuel consumptions of the Diesel engines to which they apply. As for settling-out water and impurities, this is provided for on the CUBORE by means of large reservoirs equipped with heating coils and drains. The oil from the Kinney pumps reaches these first and is given ample opportunity to settle before it is picked up by the fuel pump of the main engine. Since the elevat-

In all other respects, too, the auxiliary equipment of the engine-room and deck are of the most modern type. Elimination of the 16-ft. Scotch boiler and masses of steam piping has added greatly to the appearance of the engine-room, so that it made an excellent impression on us the moment we entered. Its spaciousness and freedom from cluttering details called to mind a modern stationary plant, and is due almost entirely to the use of motorized auxiliary equipment. Bilge and ballast pumps are of the geared double-acting two-cylinder type manufactured by Worthington and powered with General Electric motors. On the machinery flat is a $3\frac{1}{4} \times 6$ " Worthington single-stage starting air compressor, also two 2-stage Ingersoll-Rand auxiliary and reserve injection-air compressor, all direct-driven by 50 h.p. General Electric motors. To make assurance doubly sure, a two-stage Rix air-compressor is provided and is belt-connected to

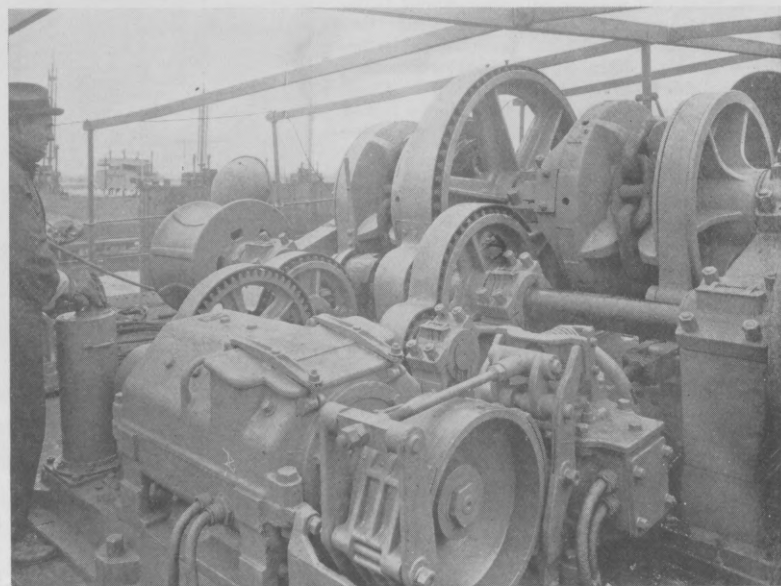
electric winches generally found in service today. They are so constructed that, without manual attention, mooring lines are played out and taken in as the ship is moved about by swells and other agencies. The lines are thus kept automatically taut at all times.

The cargo winches, ordinarily used to open and close the heavy hatch covers characteristic of ore-boats, are fitted also to handle cargo when occasion demands. To meet this service, winch control on the CUBORE is of the latest magnetic type now widely adopted and results in a saving of from 15 to 20 per cent. Arc-overs, such as frequently result in damaging contacts during slow-speed operation, as well as the blowing of circuit-breakers often encountered at high speeds, are eliminated because power is always automatically fed to the motors at the proper rate, irrespective of the velocity of operation.

Steering equipment is also a Bethlehem-



Bethlehem Co.'s. new type of G. E. electric magnetic mooring-winch showing controller case removed



General Electric motors and controls also operate the new Bethlehem anchor-windlass in the motorship *Cubore*

ing pumps circulate an amount of oil many times as great as that which the engine requires, the entire contents of a given fuel bunker pass through the settling reservoir early in the voyage, with the result that the bunker becomes progressively cleaner and freer from water as the ship keeps going. However, it remains to be seen whether even this up-to-date method of handling fuel entirely solves the problem of burning very heavy and viscous fuels, notorious for their capacity to entrain salt water to an extent such that no amount of settling and heating can get rid of it. Centrifugal separation would appear to be the only final and definite solution for the heavy-oil problem, just as it has once and for all disposed of the question of lubricating-oil purification.

In fact there is already installed on the CUBORE a De Laval number 600 purifier for the force-feed lubrication system of the main and auxiliary engines. It handles 4,000 i.h.p. worth of lubricating oil with ease, and has proved itself to be effective insurance against troubles due to contaminated lubricants.

a Novo gasoline engine of six horsepower. This makes a very complete air-compressing plant (nothing has yet been said of the main engine injection-air compressors) and makes the CUBORE safer against failure of air than an ordinary steamship is secure against the failure of steam-pressure. With every last pound of air gone out of the tanks, it would still be possible to get the ship under way by starting the Novo-Rix outfit, pumping up air for the auxiliary Diesels, and with current from the latter running one of the compressor units. Starting and injection for the main engine could thus be made available in less time than it would take to fire up the boiler of a steam vessel and to get up steam.

All deck auxiliaries, as has already been mentioned, were designed and manufactured at the Moore plant of the Bethlehem Shipbuilding Corporation, Ltd., in conjunction with the engineers of the General Electric Company. A new feature of this equipment is the automatic mooring winches, designed to perform a service unique among

General Electric product and was admired for the smoothness and precision of its working by all those who inspected it on the trial trip. There were many other items of auxiliary equipment which would be of interest here, but which lack of space forbids us to touch upon. However, an ore-ship intended for use partly in the tropics would hardly be complete without an ice-machine and it was pleasing to note that this need, too, had been efficiently met on the CUBORE with a Westinghouse-driven Remington one-ton refrigerating machine.

We append herewith in full the formal statement and accompanying diagrams and drawings issued by the Bethlehem Company describing this engine as seen by its own engineering staff and setting forth the claims made for it. This is published verbatim as a matter of general interest and as in the case of all similar communications reproduced by us, publication does not necessarily imply endorsement of all the conclusion presented, some of which may be debatable.

NEW BETHLEHEM OIL ENGINE

This Description, Published Verbatim, Has Been Prepared and Contributed by the Bethlehem Steel Co.

WHEN it has been demonstrated that an oil engine can be maneuvered with more ease and speed than a steam engine designed for the same service; when three years of experience under exacting service conditions have shown beyond question that the engine is at once unusually simple, strong, economical, reliable and easy of access for repairs; and when the engine is not only an improvement on European models but the first oil engine of all-American design, it naturally merits attention.

The new Bethlehem oil engine is the logical outgrowth of fourteen years' experience with gas engine power plant practice on an unusually large scale, using units of 5,500 horse power each, for the most part, under the hardest possible conditions of continuous steel mill service. More than 200,000 horse power of large internal-combustion engines have been designed by Bethlehem engineers and installed in Bethlehem plants.

This oil engine is the newest development and has been given a thorough try-out in both land and marine service. About three years ago one of these engines was installed in the CUBORE, a 10,500 ton motorship belonging to the Ore Steamship Corporation, a subsidiary of the Bethlehem Steel Company. As a result of this experience minor changes were recently made in the engine and on February ninth a number of experts prominent in the marine world were given an opportunity to see what it would do. The results were perfect.

Another engine of the same type is installed in and has been in successful operation at the power house of the Lehigh plant of Bethlehem Steel Company for over a year.

DESCRIPTION :

The important features of the Bethlehem oil engine are fully illustrated in the accompanying drawings and photographs. It is of the vertical, two-stroke cycle, single-acting type, constructed in units of four, six, or eight cylinders running at a speed of from 116 r.p.m. for land power and twin screw marine purpose down to 90 r.p.m. for single screw marine use. The number of power impulses given to the crankshaft per revolution is equal to the number of cylinders, thus giving a more even turning torque than would a four-stroke cycle engine. In the latter engine the number of power impulses given to the crankshaft per revolution is equal to one-half the number of cylinders. This even torque of the two-stroke cycle type makes the engine very steady in its operation, as is illustrated by a six-cylinder engine without flywheel in regular operation in our Bethlehem Power Station producing alternating current in parallel with 40,000 horse power of gas engines. The effect of this regularity of turning moment in marine service is illustrated by the case of the motorship CUBORE, which is equipped with a six-cylinder two cycle oil engine of our design developing 2,500 shaft horse power, at 90 r.p.m. This engine operates with the utmost success at all speeds down to 20 r.p.m. and under all marine conditions without the aid of a flywheel. This regularity of turning torque has particular advantages in a marine installation, in that it permits a reduction in the size of the line, thrust, and propeller shafts.

In the conversion of ships from steam to oil engine drive, a matter of utmost importance to our merchant marine, costs are reduced because the Bethlehem engine can be installed in most cases without having to increase, and therefore renew, the line, thrust and propeller shafts already in the ship. This is an important factor in selecting a Diesel oil

engine for marine conversion work. The engine here described is, as before stated, of the two-stroke cycle (called hereafter two cycle) vertical, single acting cross-head type, the scavenging air being admitted through one valve in top of cylinder, and the exhaust gases passing out through a ring of ports extending entirely around the circumference of lower end of cylinder.

Power is produced by the combustion of liquid fuel delivered into the cylinders in a highly atomized state by the aid of compressed air. The combustion cycle is of the full Diesel type. The

from the operation of oil engines under heavy load.

To accomplish this object the power cylinder was designed as indicated in accompanying photograph "A" and section through engine "B." It will be seen that the inner and outer cylinder walls are united only at the top and at a point entirely removed from heat of combustion. By means of the flanges shown, the cylinders are mounted in pairs in a casting designed to receive them. The power cylinder projects downwardly through this casting, to which it is attached only at the upper flange. Consequently the cylinder is free to expand in all directions without setting up stresses in any working part. Since, as previously explained, the inner and outer cylinder walls are only attached at upper end, it is evident that the inner and outer walls may expand at different rates without setting up any temperature stresses in power cylinder.

Since in any internal combustion engine the inner cylinder wall is subjected to flame inside and water outside, and since the outer cylinder wall is subjected to water temperature on inside and engine room temperature on outside, it is evident that such differential expansion between inner and outer walls must inevitably occur. These expansion differences in length increase as the stroke and consequent length of power cylinder increases. The construction of the Bethlehem engine is carefully planned to avoid trouble from this source. As the photo well shows, the cylinder is cast with the water jacket space very open and accessible. This opening in the outer jacket wall is closed by a light cast iron sleeve attached to the power cylinder at its upper end by a flange and provided at its lower end with a water joint permitting axial expansion without danger of leakage. This sleeve does not appear in Fig. A., but is well shown on sectional drawing B. This cylinder construction permits the cores to be accurately supported and provides for the adequate inspection and cleaning of every square inch of the water jacketed surface.

It will be noted that exhaust ports are cast integrally with the cylinder barrel, thus avoiding any joint between cylinder barrel and exhaust ports. Such a joint, if present, would have to hold hot gases on one side and water on the other. In using fuels high in sulphur, this element will also of course be present in engine exhaust, and the slightest water leak through such a joint would produce troublesome corrosion. It seems best to us to avoid this risk by using a construction not requiring a joint of this kind.

By reference to sectional drawing B it will be seen that the cylinder is held down to its cylinder support by studs passing through the two upper cylinder flanges. The combustion pressure in any power cylinder is exerted downwardly on piston and upwardly on cylinder. With our construction this pressure passes directly to the cylinder flanges and studs and so to the cylinder support, which is held down to A frames and bed-plate by means to be hereafter described. With the construction shown it is evident that no axial tension stresses whatever pass through the cylinder barrel or exhaust ports so that all danger of the cylinder castings being cracked due to the working stresses set up by the explosion pressures is eliminated. If any cylinder provided with a belt of exhaust or inlet ports is bolted down by its lower end, it is evident that the explosion pressures acting between piston and upper part of cylinder must create axial stresses passing through bridges between ports.

If any shrinkage stress exists in the casting it is most likely to be found near these ports. The working stress is then almost certain to crack the cylinder somewhere through these ports, which are of course the weakest part of any cylinder subject to axial stresses. In practice it is impossible to make sure that such shrinkage stresses do not exist to

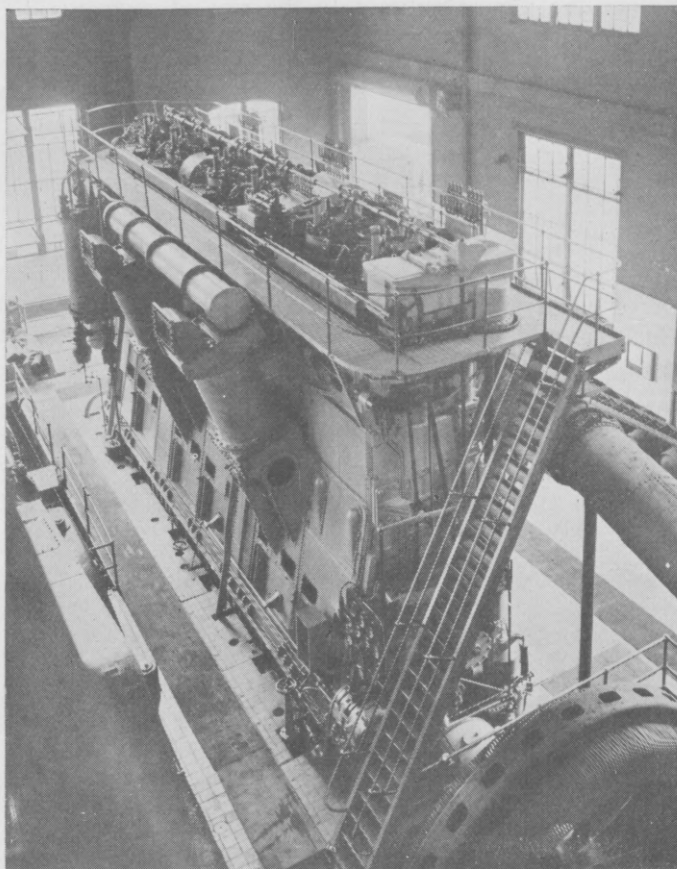


Fig. 1. Bethlehem engine photographed in power plant from above

cylinder air charge is compressed to such a pressure that the heat of the air is sufficient to ignite the atomized fuel when sprayed into the cylinder.

Cylinder: The basic idea was to create an engine in which all parts subject to flame temperatures would be so designed as to be able to resist successfully for an indefinite time the combination of temperature and pressure stresses inseparable

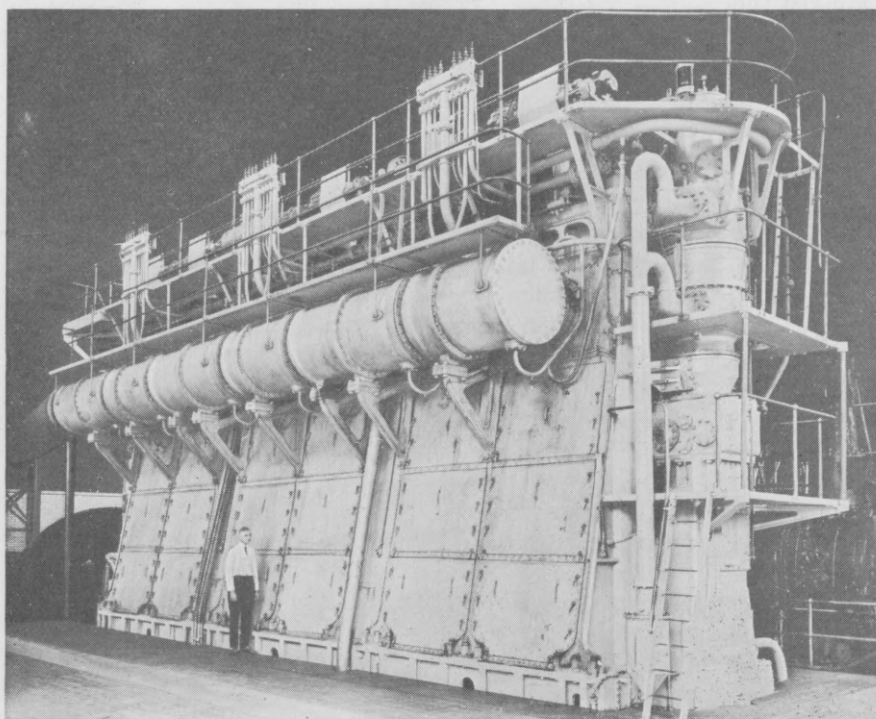


Fig. 2. This illustration gives a good idea of the overall size of the engine

some extent. Our construction avoids this danger by entirely doing away with axial stresses in cylinders.

In the two previous paragraphs we have explained how we avoid stresses due to temperature and axial stresses due to combustion pressure in cylinder. This pressure also produces stresses tending to burst the cylinder. These bursting stresses cannot, in an internal combustion engine, be safely reduced by increasing the thickness of the cylinder walls, because each square inch of the wall, particularly at upper end of cylinder, must pass a large amount of heat to the water jacket in a very short space of time. The greater the wall thickness, the greater the consequent difference between the temperatures of inside and outside surface of cylinder walls. The greater such difference in temperature, the quicker a cylinder will fail, due to heat fatigue.

The practical success of an internal-combustion engine depends upon the avoidance of such heat fatigue stresses, and the necessity of care and skill in the design of

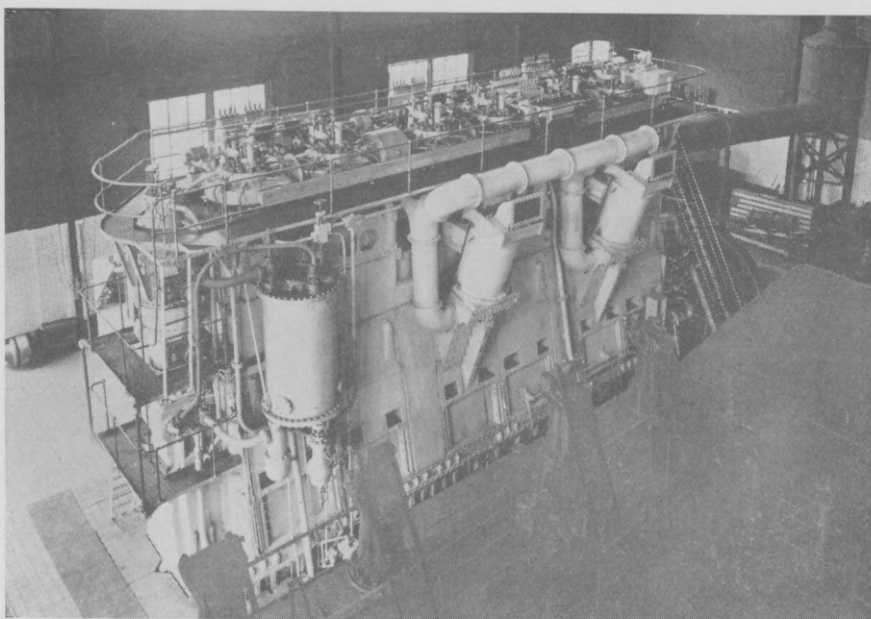


Fig. 3. Direct-driven scavenging pumps are mounted on a slant and are provided with aluminum heads. At the left is a three-stage intercooler for the injection air compressor

top center. By reference to Fig. C it will be noted that this portion is very efficiently cooled by the water jacket, which extends to a point of the cylinder wall above the bottom of inlet cage. The hot cylinder walls, thus efficiently cooled by water, are also cooled on the inside surface by the scavenging air. This enters through a mushroom shaped scavenging valve. The shape of the cylinder is so designed that the incoming current of scavenging air passes directly along this heated wall surface, thus absorbing from it a very material amount of heat in addition to that passing to the water jacket.

The hottest portion of the cylinder walls is thus practically freed from the danger of heat fatigue for three reasons. First, Cylinder walls are very strong form, with very moderate and uniform thickness in upper portion. Second, Cylinder walls are very efficiently water cooled. Third, Cylinder walls are positively air cooled on their inside surface by the scavenging air. It should be especially noted that cooling done by the scavenging air not only helps to maintain the cylinder wall at a safe temperature, but

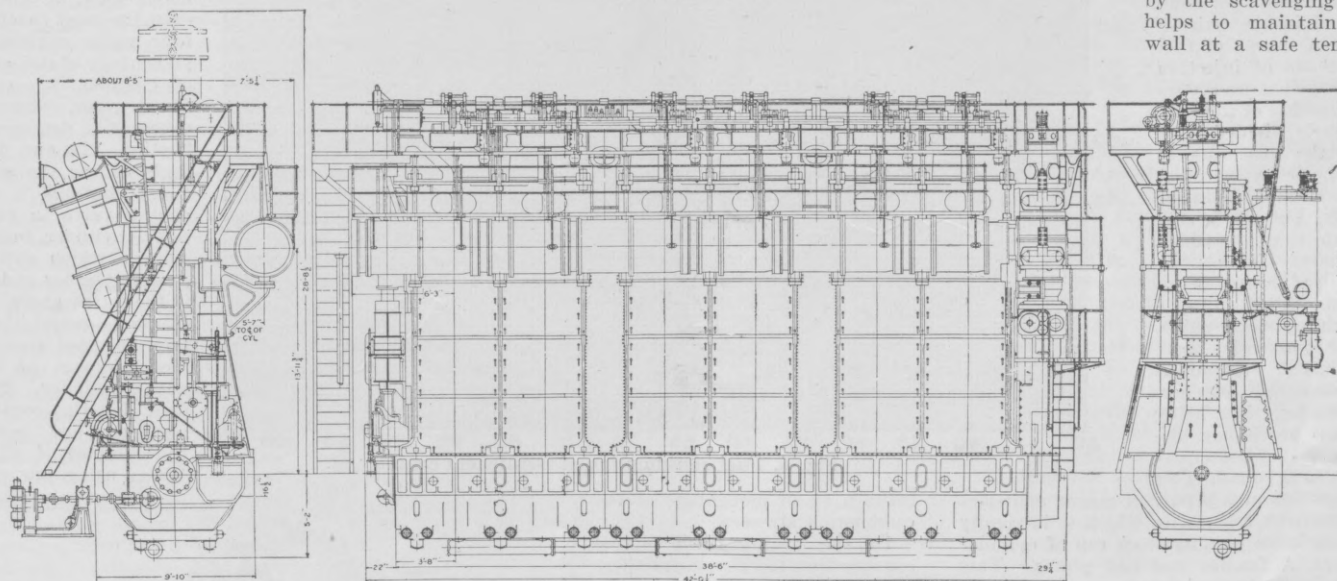


Fig. 4. Rear and side elevations of Bethlehem engine, a duplicate of which is installed on the motorship *Cubore*

cylinders naturally increases with the size of same, since thickness of walls must increase with diameters of power cylinders. To cover this point the Bethlehem power cylinder has been designed as shown in Section B and in larger scale in Section C. It will be noted that upper part of cylinder is contracted from diameter of bore to that of inlet valve cage. This form, as compared to an open ended cylinder, greatly increases the strength of cylinder without necessitating an increase in thickness of cylinder walls.

A practical instance of the increase in strength gained by the adoption of this form is found in the ordinary steel bottle containing gases under very high pressure, such as oxygen or carbonic acid gas. It will be noted from Figs. B and C that our cylinder wall thickness is very uniform in all that portion of cylinder subject to maximum temperature and pressure, the wall thicknesses decreasing with the lower pressures in lower part of cylinder. Such uniformity in section causes uniform change in shape when heated.

The part of the cylinder subject to greatest heat is that portion between lower end of inlet cage down to that portion of cylinder wall covered by packing rings when piston is at or near

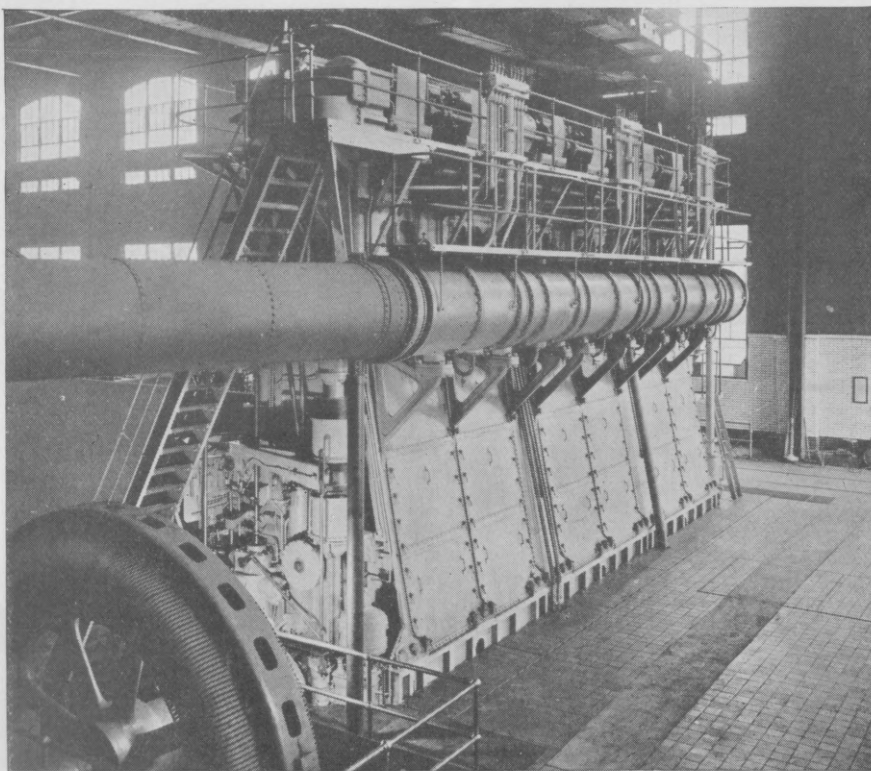


Fig. 5. The governor and its control can be seen under the ladder between the generator and the engine

that it also thereby increases the efficiency of combustion, since all the heat absorbed by the air from the cylinder walls is added to the working cycle of combustion.

Other heated parts. It will be seen that the only other parts exposed to maximum temperature and pressure are the power piston, inlet cage, scavenging valve and fuel valve. Of these, the piston, inlet cage and fuel valve are water-cooled, while the scavenging valve is positively cooled by the incoming scavenging air, which thereby gains heat and efficiency in same manner as described for cylinder wall. The perfection of cooling of scavenging valve and the seat against which it bears is well illustrated by the fact that during a period of more than three years' operation of these engines at heavy loads we have never been able to detect any ill effects due to heat on these parts. The same remark is true of the fuel valve.

We desire to call special attention to the fact that all parts subjected to heat, viz.; cylinder, piston, inlet cage, scavenging valve and fuel valve are all exactly symmetrical with reference to the axis of cylinder, have each a uniform wall thickness, and are each efficiently cooled. Under the varying temperature conditions

existing in the power cylinder these parts therefore expand and contract uniformly and the heat is disposed of in a manner which entirely prevents heat fatigue of any part. During three years' hard service it has never been necessary to replace any part on this account.

Removal of Parts. It should be especially noted that absolutely all working parts except piston, necessary for the operation of a power cylinder, viz.: fuel valve, scavenging valve, air starting valves and relief valve, are contained in a single compact and easily removable cage, well shown in Figs. D and E. Any practical man will readily appreciate the value of this construction.

General Construction. Having thus described the effect of combustion on parts exposed to heat it is necessary to trace the action through the engine of the pressures generated by such combustion, which takes place as follows: Let us start with the piston on top center, at which point atmospheric air has been compressed to about 450 lbs. per sq. in. Into this compressed air, and in the axis of power cylinder a charge of fuel is blown by means of injection air in such a way that we secure thorough atomization of the fuel, which in its finely divided state is ignited by the heat due to compression of air in cylinder. Pressure is thus generated, not instantaneously, but at a rate proportional to that at which fuel is introduced. This pressure is transmitted downward to crankshaft and bed-plate through piston, piston guide, crosshead and connecting rod. The pressure which acts downward on piston also acts upward on cylinder, thus being transmitted, as previously described, to the cylinder support to which cylinder is bolted. This cylinder support contains a pair of power cylinders and rests on three A frames, to which it is rigidly held by six long bolts passing from top of cylinder support through A frames and bed plates. This construction is well shown in accompanying drawings B and D. When engine is erected, these long bolts are tightened so as to produce an initial tension in same about 25% greater than the maximum tension arising from combustion pressure in cylinder. The bolts are of such a size that this initial tension is not more than 20% of the elastic limit of the material. Since the initial tension in bolts is more than the maximum tension due to combustion pressure, it follows that the bolts do not stretch in the slightest degree while engine is working. The A frames are therefore always in compression.

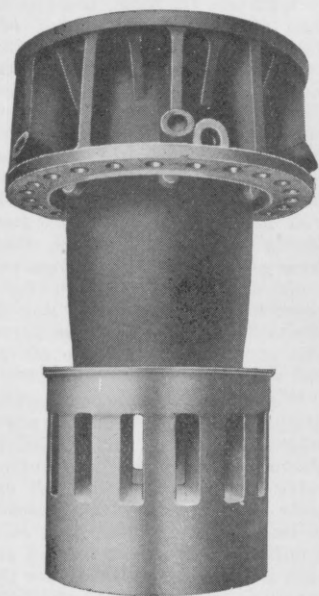


Fig. A. Cylinder-head and barrel showing good cooling of combustion space and copious exhaust ports.

Since cylinders are held to bed-plates only by these large bolts passing through A frames it follows that the latter can never be subjected to tension under any circumstances. This construction gives the utmost rigidity without undue weight, because the cast iron A frames need be designed only for compression, since the large bolts absorb all the working stresses, producing tension, leaving the A frames subject only to compression stresses due to initial tension of bolts, weight of parts supported by frames, and on a ship, to such stresses as are due to the rolling of vessel, these latter

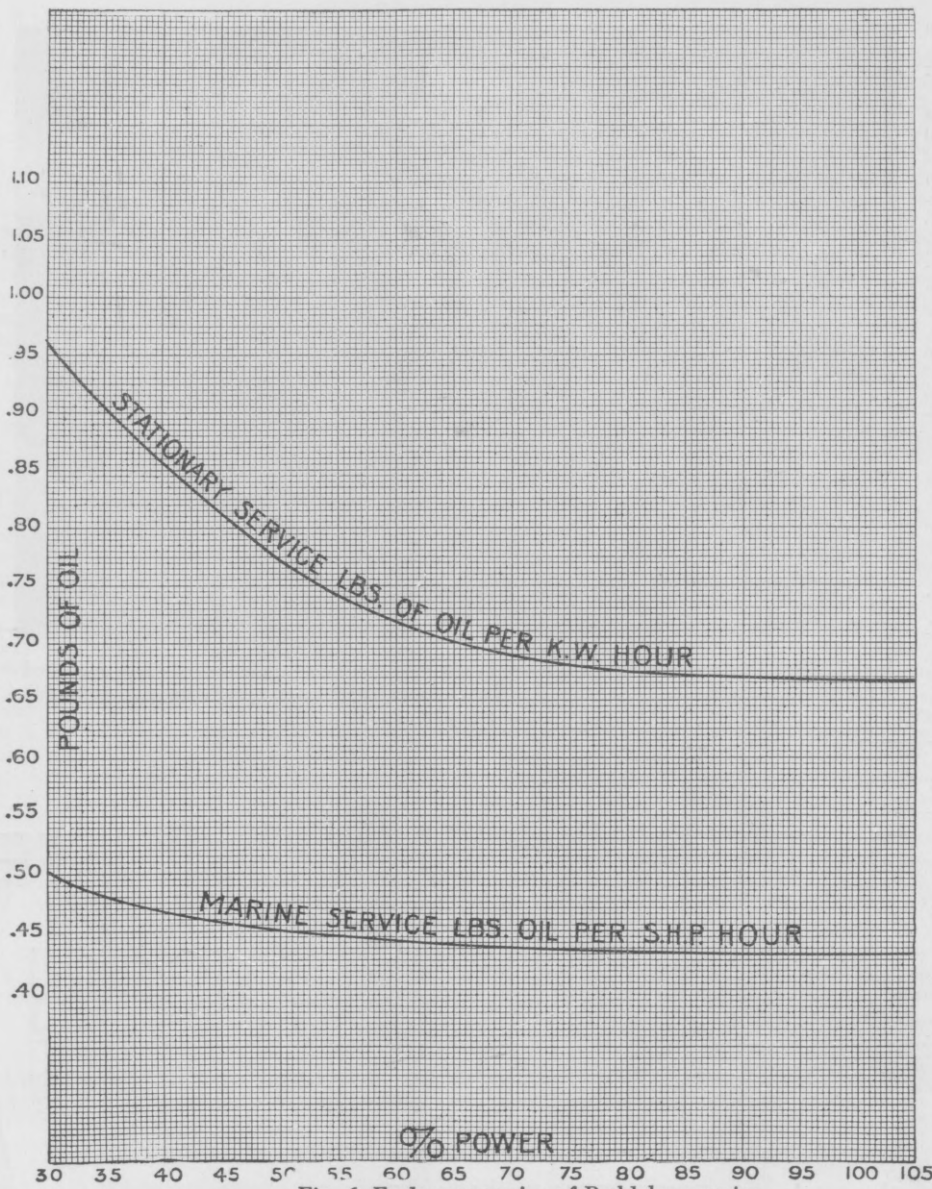


Fig. 6. Fuel consumption of Bethlehem engine

being a small percentage of the combustion stresses.

In the ordinary oil engine construction the power cylinders are bolted to the A frames, the feet of which are bolted to bed-plates near outer edge. This arrangement subjects the whole width of bed-plate to bending stresses arising from combustion pressures, with the deflection of bed-plate consequent thereto.

Bed-Plate. By reference to Figure D it will be seen that in our design these large bolts pass clear through the bed-plate quite close to main bearing, the distance from center to center of bolts being less than half the width of the bed-plate. Since the part of the bed-plate subject to stresses arising from combustion pressures is only the portion between these bolts, it follows that the span of bed-plate subject to such stresses is less than half, the stresses in bed-plate, being consequently less than one-quarter, and the deflection of bed-plate less than one-eighth of those encountered in the ordinary design.

The combustion pressures on power piston acting on bed-plate naturally set up tension stresses in lower side of bed-plate between the large bolts. To resist these tension stresses, the bed-plate is provided in its lower part with the horizontal bolts shown in figures B and D. During erection these bolts are subjected to an initial tension about 25% more than the maximum stress due to combustion pressure, the same as described for the large vertical bolts. No deflection of bed-plate can therefore occur, and there is no possibility of a cracked bed-plate due

to shrinkage strains in same.

It will be seen from the above description that no part either of the A frames or bed-plates is subject to tension, such tension stresses being exclusively taken by properly designed forged steel bolts, leaving to the cast iron parts only compression stresses, to resist which cast iron is well adapted. Since the cast iron parts are relieved of tension, and the forged steel tension members are designed for and tested at stresses materially exceeding those resulting from the maximum load for which the engine is guaranteed, it follows that no failure of these parts in service is possible.

Scavenging. Perfect combustion in any oil engine requires that the power cylinders be efficiently cleared of exhaust gases. The clearance space in a four cycle engine cylinder, amounting to about 7½% displacement, cannot be cleared of exhaust gases. Due to the fact that at the end of exhaust stroke these gases must be at a pressure above atmosphere great enough to expel the gases from the exhaust pipe, it follows that in even the most carefully designed four cycle engines a material percentage of the suction volume of cylinder is occupied by exhaust gases, whose presence is necessarily detrimental to combustion. In our design of two cycle engine the scavenging air enters through a central scavenging valve in extreme upper end of cylinder, forming an axial column which entirely fills the power cylinder and drives before it the burnt gases, which escape through very liberal exhaust ports located around the entire circumference of lower end of power cylinder. It will be evident that this construction must perfectly and positively clean the cylinder of all burnt gases. When using low grade fuels, a

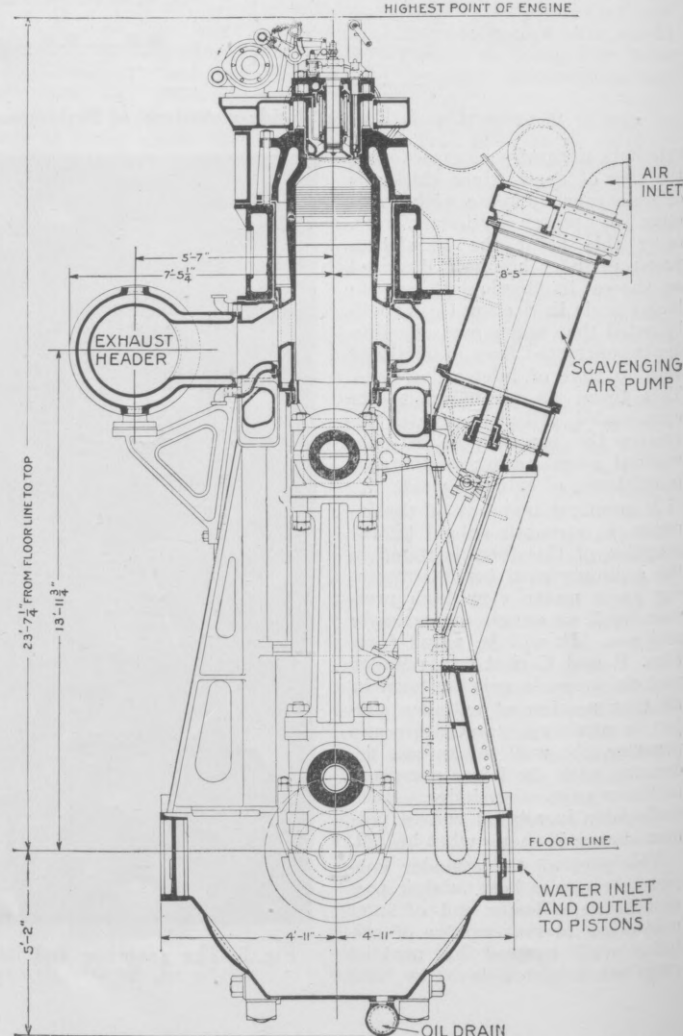


Fig. B. Section through engine cylinder and one of the scavenging pump-cylinders.

certain amount of residue is sometimes deposited on top of pistons.

With our construction such residue deposited in any stroke is, at the end of this same stroke, positively blown out into the exhaust passages before it has time to be hardened by heat. In any design in which gases are exhausted from the upper end of cylinder it is evident that such residue cannot be so expelled and is therefore apt to be burned on the piston and rings. The hard deposit thus formed sticks the rings and greatly increases the cylinder wear. It should also be noted that with this system perfect scavenging can be obtained, no matter how long the stroke may be for a given cylinder bore. The small bore long stroke engine is more economical in fuel and lower in repair cost than an engine of the same cylinder displacement and piston speed, but in which the stroke and bore are more nearly alike, thus necessitating a higher r.p.m. The gain in economy and repair costs by building an engine of a given horsepower of small bore, long stroke and low revolutions has always been evident in steam reciprocating engines, but is still more important in internal combustion engines, due to the higher temperatures and pressures necessarily employed.

Engine Speed. For oil engines employed for marine service there is an additional reason for slow revolutions, because in this way a better screw efficiency can be obtained. Our type is thus especially adapted for this service. For merchant marine ships single screws are cheapest and most efficient. This condition, together with the required slow revolutions, is best filled by the two cycle engine, since the four cycle engine will not furnish the necessary power to a single screw without increasing the engine speed beyond the economical limit in screw speed, solely to help the four cycle engine deliver the power. For this reason most merchant ships driven by four cycle engine are of the twin screw type. The same shaft horsepower can be delivered by a single two cycle engine, thus making possible a far simpler and cheaper power plant in the ship. It is worthy of note that the two cycle engine is especially adapted to drive a screw because the efficiency of both engine and screw increase as the r.p.m. decrease.

Injection Compressor. Injection air is supplied by a three-stage air compressor driven from a special crank on one end of the crank shaft. Particular care has been taken in designing this compressor to assure reliability in continuous service under both land marine conditions. The use of compressed air for fuel injection gives better atomization and combustion economy over a much wider range of fuels, particularly among the heavy and cheap grades, than any other injection system yet developed. We have used with entire success distillate fuels down to 16° B.

Regulation of Injection Air. Our engineers, looking for refinement of control and economy at all speeds and powers, have developed a system of fuel valve lift control. This permits the lift of all fuel valves to be quickly regulated from zero to full lift at any moment by the operator when maneuvering the engine. The proper air and oil ratio may therefore be maintained under all conditions. When maneuvering a marine engine or when starting up a land engine, the injection air may be conserved and used in the proper amount, instead of in excess as is the case with a constant lift fuel valve.

Removal of Pistons. A simple device is furnished with the engine for removing pistons from the bottom of the cylinders without disturbing any of the valve gear or piping on top of the engine. The advantage of this construction have been proved by extensive operation under both land and marine conditions. This device is well illustrated in Figures G, H, I and J showing successive stages by which access to power piston is quickly and conveniently obtained.

Ease of Maneuvering. In selecting power units for ships, the ease and flexibility of maneuvering with the main engine should be given careful consideration. The Bethlehem Oil Engine is especially adapted to meet these requirements, due primarily to the simplicity of the reversing gear, to the fuel valve lift control, and to the fact that fuel can be injected into the cylinders without having to shut off the starting air. This last advantage is of particular importance because the engine remains turning over with air until combustion takes place

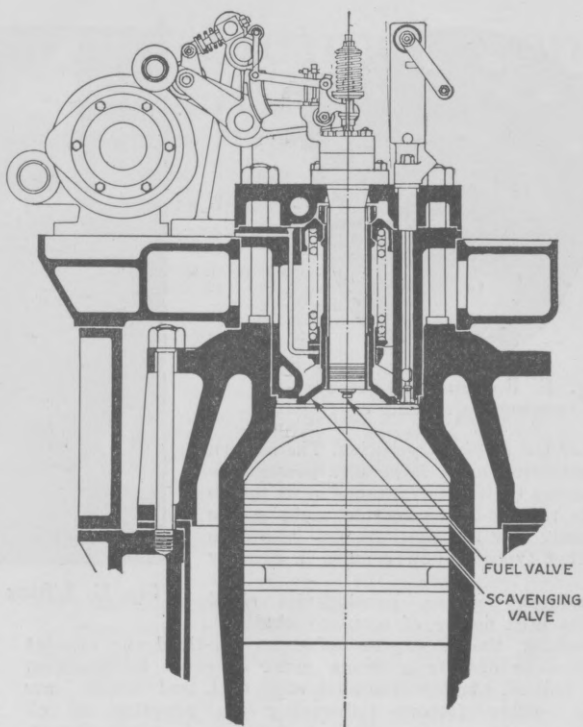


Fig. C. Section through scavenging valve and combustion space

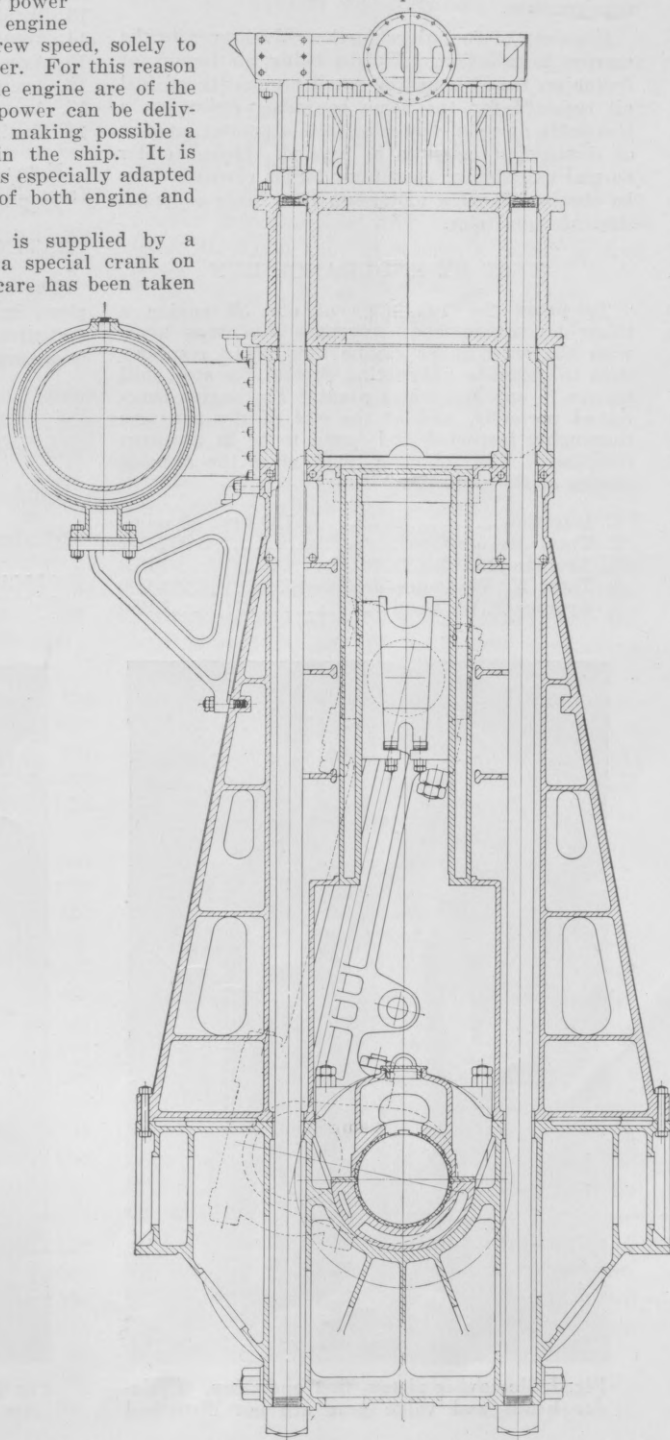


Fig. D. Section through main bearing showing one half of the double center crosshead

in a sufficient number of cylinders. The reversing gear is simple because there is only one camshaft. The same set of cams is used for both ahead and astern operation, the camshaft being turned by an air operated reversing gear for the proper timing of the valves in either direction.

Reversal from full ahead to full astern may be accomplished in from ten to fifteen seconds, while positiveness and reliability have been proved under actual operating conditions. The reversing gear and gauge board are at the forward end. The left hand lever admits starting air to all power cylinders, all of which receive fuel injection simultaneously. When combustion takes place the further ingress of starting air is automatically prevented. A central lever controls the amount of fuel injected into cylinders, and works in a double slot somewhat similar to the selective gear lever on an automobile. The lever is normally in the left hand slot, in which case it supplies fuel for operation ahead, the amount of fuel being increased by pushing the lever farther from the operator.

When the operator wishes to reverse he pulls the fuel lever toward him as far as he can. This shuts all fuel off the engine. He then moves the lever to his right as far as possible. This, by means of the valves shown admits compressed air into an operating cylinder which rotates the camshaft so as to bring the cams into the proper astern position, in which position the gear is automatically locked.

When the gear has moved into its extreme position, the lever may be pushed out into the right-hand slot, but the operator is prevented from doing this until air interlocking device is moved out of the path of the lever by the action of the reverse gear completely reaching the end of its travel. The fuel lever is moved out into the astern slot far enough to give the desired power and the engine then goes astern when the operator moves the left hand air lever away from him. It will be seen that this reversing gear is absolutely fool-proof for following reasons. First. Engine cannot be reversed without first entirely shutting off the fuel. Second. Engine cannot be given fuel in reverse direction until reverse gear has completely moved into the proper position. It will be seen that no matter how excited the operator may become in any emergency, he cannot possibly go wrong. The right hand lever determines the lift of the fuel valve so as to properly control the injection air at all speeds and powers, as previously explained. This arrangement has the additional advantage that the engine can, in case of emergency, be started without the necessity of charging the injection air bottles beforehand.

Scavenging Compressors. The scavenging compressors are arranged on an incline, and are driven from main connecting rods, as well shown in Fig. B. The scavenging pistons are very light, being made of an aluminum alloy. The scavenging piston rods are very light, being hollow. Due to the lightness the scavenging piston bears very lightly on the lower side of cylinder wall. After 15 months' continuous operation it is impossible to detect any more evidence of wear on lower side of scavenging cylinder than on the upper side. Since the total forces due to one scavenging compressor are less than 2% of those passing through the main connecting rod by which compressor is driven it is evident that no more wear will be found on this main crank pin than on the others. Fifteen months operation have actually proved this to be the case. This inclined scavenging compressor drive has been proven by long continued hard service to be actually an unqualified success. Its advantages are manifest. It does not lengthen the main engine an inch, and still more important, it does not increase the number of crank-shaft bearings which must be kept in line. This detail is especially important on a ship. This arrangement of scavenging compressors also does not take up any floor space whatever, does not increase the height of the engine and does not materially increase the weight of the engine. These points are all very important on a ship.

Unit Design. The general design of the engine is based upon the unit system, each consisting of two power cylinders, cylinder support. A frames, bed-plate section and crank-shaft section. This enables the engine to be built as a two, four, six or eight cylinder cylinder motor by combining the units. The crankshaft sections are inter-changeable, each consisting of two cranks set 180 degrees apart together with flanges on each end, forming an integral part of shaft. The timing of cranks needed for different combination of cylinders is obtained by the manner in which the shaft sections are bolted together.

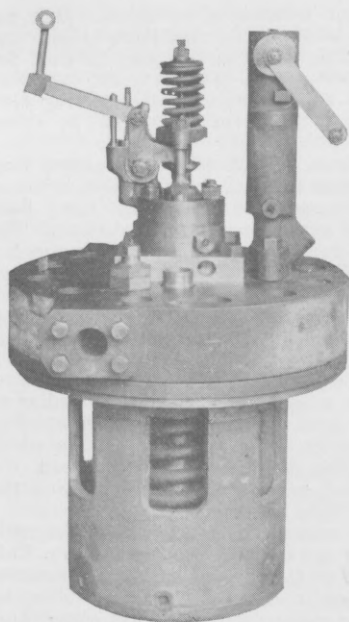


Fig. E. Scavenging valve cage with fuel and relief valves

The construction of the section with the cranks opposite has two advantages. First, the inertia forces of the reciprocating parts attached to these cranks are, except for the angularity of the connecting rod, equal and opposite. The vertical planes in which these opposing and counterbalancing forces act are closer together than is possible with any other crank arrangement. The comparative closeness of these planes of action therefore keeps down to a minimum the tendency in a ship to produce periodic vibration. The CUBORE, having a six-cylinder engine, is for this reason remarkably free from such vibration. The second advantage in constructing a shaft section with two opposite cranks is very important from a practical point of view. The whole crank-shaft section is in one plane, from which it results that on a six or eight cylinder engine a center section of crank-shaft can be removed end-wise without disturbing either the other crank-shaft sections or any part of the A frames.

It is evident that a shaft section consisting of only two cranks 180 degrees apart is very much easier to handle in cramped quarters than a section consisting of three cranks set 120 degrees apart, this latter being a common construction adopted by other builders. As previously described, the injection air compressor is driven from the forward end of the engine. To preserve the interchangeability of crank-shaft sections, the small crank driving the injection compressor is bolted to the forward flanges of the forward section.

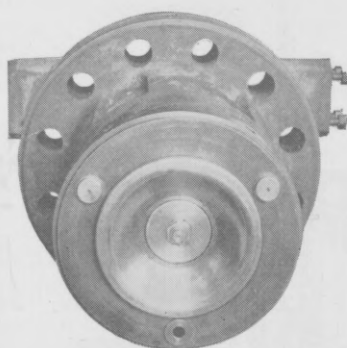


Fig. F. Bottom view of scavenging valve and cage

Advantages of Oil Engine Operation. The modern oil engine, considered as a large-unit power producer, has so many decided advantages in its operation that it is rapidly becoming the main source of power in many new installations, and also even supplanting other types of power units in existing installations.

The predominant feature, causing its rapid adoption, is the high degree of economy obtained.

Generally speaking, the oil engine consumes one-third the amount of fuel it takes to operate a steam plant of equal horse-power. Absence of boilers, boiler room force, coal, and smoke are other factors influencing the adoption of oil engine power. The elimination of standby losses, and the ease and rapidity of starting, particularly fit the oil engine for intermittent service requirements.

Economy of fuel gives further advantages to the marine installation. Weight being an important factor on board ship, the smaller quantity of fuel oil required for the same operating radius as a steamship of equal power permits a greater amount of deadweight cargo to be carried. Hence, under normal and similar conditions larger revenues may be obtained from a motorship than from a steamship of equal size.

TEST BY ENDURANCE RUN

To prove the reliability of our oil engine a thirty-day continuous endurance run was made with the six-cylinder engine now being regularly used to generate alternating current for steel mill service in our Bethlehem plant. The engine functioned perfectly, and at the end of the run was thoroughly inspected and found to be in excellent condition. The following data gives the average results of the test:

1. Duration 730 hrs., 35 mins.
2. Total Revolutions 5,057,997
3. Average R.P.M. 115.3
4. Total K. W. hours produced 1,211,900
5. Average K.W. Load 1,659

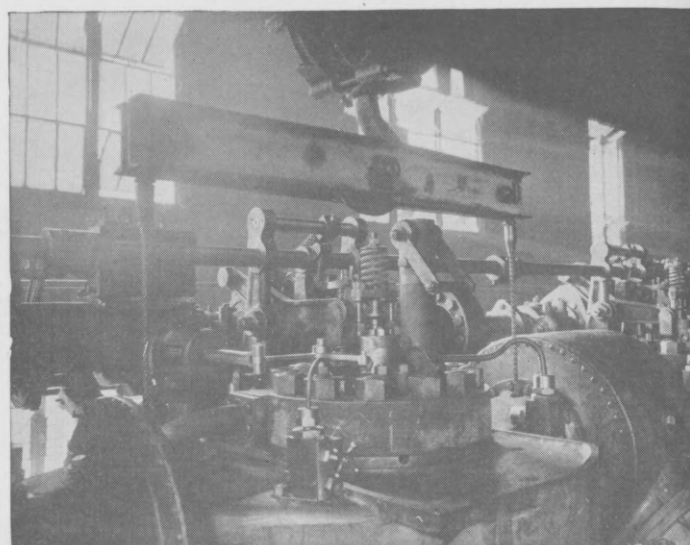


Fig. G. Lifting tackle on the Cubore expedites upkeep routine

6. Average B.H.P. 2,522
7. Average I.H.P. 3,582
8. Average Mech. Efficiency 70.4%
9. Total pounds Fuel Oil consumed 849,829
10. Average pounds Fuel Oil per K. W. hour .. 0.70
11. Average pounds Fuel Oil per B.H.P. hour 0.46
12. Total gallons Bearing Oil consumed 716.0
13. Total gallons Cylinder Oil consumed 189.5
14. Total pounds Cup Grease consumed 158.5
15. Average gallons Bearing Oil per hour 0.98
16. Average gallons Cylinder Oil per hour 0.25
17. Average total gallons Lubricating Oil per hr. 1.23
18. Equivalent Sea Milage of Total Revol. ... 8,700

Note: Ordinary plant fuel oil was used, varying from 22°-30° Beaufort with high sulphur content.

RATINGS OF BETHLEHEM OIL ENGINES

The ratings of the Bethlehem Oil Engine are given in the table below. These ratings are conservative and are based on operation of the engine in severe, continuous service.

Number of cylinders	Stationary or Twin-Screw Marine Service			Single-Screw Marine Service	
	Revolutions per minute	Brake horse power	Kilo-watts	Revolutions per minute	Brake horse power
4.....	116	1,950	1,300	90	1,600
6.....	116	2,900	1,950	90	2,400
8.....	116	3,900	2,600	90	3,200

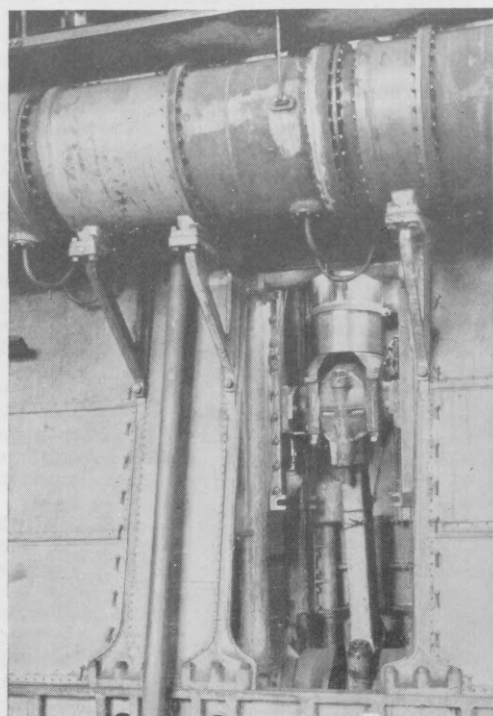


Fig. H. Removing piston, second operation
First operation shown in Fig. I

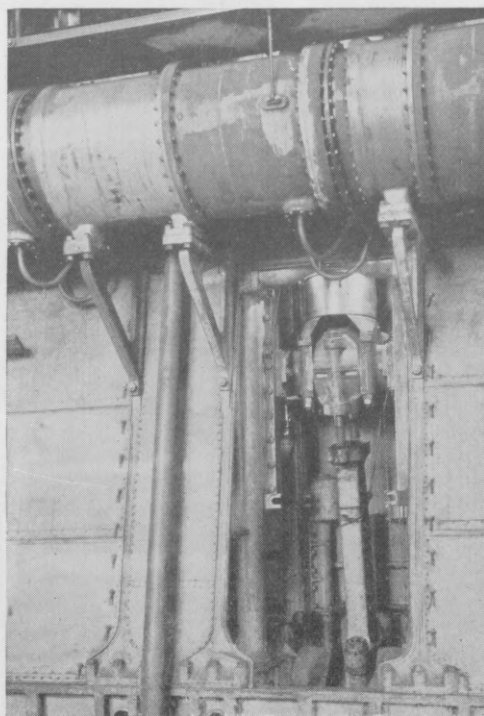


Fig. I. Removing piston, first operation. Cylinder heads and valve gear are not disturbed

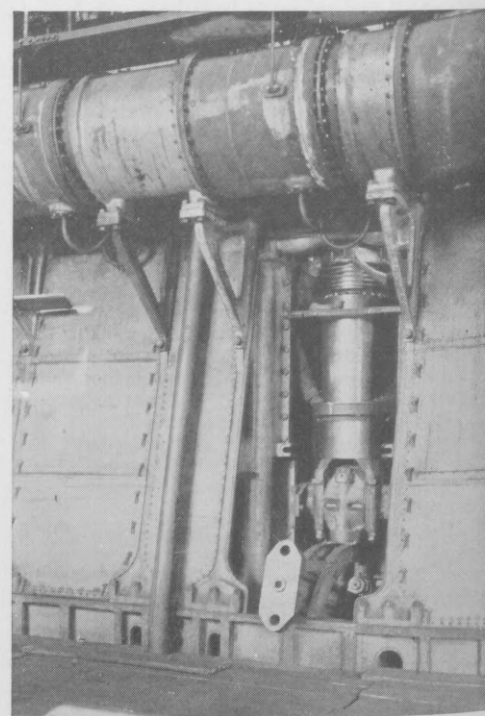


Fig. J. Piston ready to be slid forward and out through the crankcase door

Congress and Steamer Conversions

Statement of J. F. Metten, Chief Engineer, Cramp Shipbuilding & Engine Co.

Mr. Metten: In connection with the proposed conversion I might say that the Cramp Co. made the installation in the *William Penn* and subsequently built two more ships for an American line running in the inter-coastal trade, which are 12,000-ton ships, and, owing to the better models, had an average speed of 12 knots. But the most interesting development, perhaps, is the fact that we took one of the Hog Island class A ships about a year ago and converted her into a single screw Diesel ship. She is typical of the conversion that Admiral Benson is contemplating generally. She is about 8,000 tons dead weight as a steamer, and there are 100 of those ships built at Hog Island exactly alike.

She is on her first trip to the west coast, the last report we had from her being on her eastbound trip from Tacoma. As a steamer she burned as the average performance of the 60 or 70 of these ships about 29 tons of fuel-oil a day. Her consumption as a motorship is $7\frac{1}{2}$ tons per day. The speed of the motorship is a trifle better. She has averaged about $10\frac{1}{2}$ to 11 knots. Her deck crew is the same as when she was a steamer. But her engine-room crew has been reduced by the number of men required in the fireroom. She carries six engineers and a chief, and as a steamer they carried two men in the fireroom, a water tender, and a fireman, which made six additional men. *By converting her into a motorship her dead weight for a given voyage was increased nearly a thousand tons.*

Conversion Gave Increased Capacity

Mr. Edmonds: In other words, the space that was used for the engine room, when she was given the Diesel engine installation, gave you a thousand tons more capacity?

Mr. Metten: We took out the deck tank. A motorship carries oil enough, double bottoms and something like 40,000 knots capacity, capacity enough to go around the world and half way around again.

Mr. Edmonds: That increased your carrying capacity 1,000 tons?

Mr. Metten: It depends on the length of the voyage, and with the length of the voyage, her cargo-capacity increases. When the operator sent her around the west coast they put on 200 tons of fuel oil and she burned 150, a steamer would have had to put on 600 tons for the westbound trip. That meant that that difference would be variable for the cargo in the case of a motorship. The weight of the Diesel machinery is the same, approximately, as the weight of the steam machinery that was taken out. I might say, too, that steam-propelling machinery that was taken out of the ship is still in the yard and we will have to sell it for junk because there is no demand for it.

Mr. Davis: Is it considered that there is any material difference in the life of the internal-combustion system and the oil-burning system?

Mr. Metten: No. As a matter of fact, the first large motorship that went into service was the *SELANDIA* operated by the East Asiatic Co. to the Far East about 11 years ago, and the last time we had some one to inspect her she was apparently as good as ever. In a motorship you could renew the

Testimonies Given Before the Committee on Merchant Marine and Fisheries, House of Representatives, Washington, D. C.

MEMBERS OF COMMITTEE

George W. Edmonds.	Ladislav Lazaro.
Frank D. Scott.	Edwin L. Davis.
Wallace H. White, Jr.	Schuyler Otis Bland.
Frederick R. Lehlbach.	Clay Stone Briggs.
Benjamin L. Rosenbloom.	William W. Larsen.
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Frank R. Reid.	Jeremiah E. O'Connell.
George M. Wertz.	Dan A. Sutherland.
Robert L. Bacon.	

R. G. de Tonnancour, Clerk.

Second Installment

(Continued from page 133 February)

cylinder liners at comparatively small cost—they usually run 8 to 10 years—and when that is done you have practically reconditioned your ship. As a matter of fact the average life of a set of Scotch boilers is not more than 12 to 14 years, and when you renew them it is a very expensive proposition. I have three Scotch boilers now that cost in the neighborhood of \$45,000 to \$250,000, without the installation costs.

Mr. Briggs: How many leading types are generally recognized among Diesel engines?

Mr. Metten: Four to six, you might say, standard types. I suppose five or six. Certain types have been adopted for small units, but if you come down to installations that have proven successful in the larger ships above 6,000 to 8,000 tons it narrows down to five types.

Mr. Edmonds: You are only speaking of Diesel engines that are applicable to ships.

The Diesel Patent Question

Mr. Briggs: How many basic patents cover this engine?

Mr. Metten: It probably goes into thousands. There is not any other one subject covered or which has resulted in as many patents as the Diesel engine.

Mr. Briggs: My understanding thus far is that the cost of the Diesel engine is rather high. Can you give us some reason why the cost should be so high? I was wondering whether the royalties paid under the patents might not enter into the prices of the material.

Mr. Metten: The Diesel engine requires a good grade of workmanship and less material; but the principal reason for the high cost in America is the fact that no builder has had the opportunity of building more than one ship at a time.

Mr. Briggs: Almost hand-made or custom-made?

Mr. Briggs: Your company does the work of reconditioning and conversion of the ships?

Mr. Metten: Yes; we buy from the Shipping Board outright and carry out the conversion.

Mr. Briggs: What is the cost?

Mr. Metten: We have not the return of cost for that type yet. It was delivered about a month and half ago. I do not know what the actual returns are. The accounting will be finished some time this month.

Mr. Briggs: You have made an estimate, I am sure, in your company of what this conversion cost would approximately be, have you not? You heard the testimony this morning by the Shipping Board officials?

Reducing Conversion Costs by 35%

Mr. Metten: I think that is about right if

conversion is carried out on something like 10 ships at a time. The cost of the conversion of 10 ships will probably be 35 per cent less than 1, probably more than that.

Mr. Davis: In this connection I would like to get your opinion on what this reconditioning could be done for per ton on a contract for 10 ships in the light of the experience which your company has had.

Mr. Metten: Around \$50 a ton for the *WILLIAM PENN*. That is the contract price.

Mr. Davis: Is there any material difference in the cost of installation of the different standard types of internal-combustion systems?

Mr. Metten: I do not think there is a great deal in the real first-class engines that are actually in operation. There is quite a difference in cost between twin-screw installations and single-screw installations. This morning some question was raised about the difference in crew. Reference was made to the comparison the Shipping Board had shown to Mr. Sheedy, where the motorship required more care than the steamer, and in that case he was comparing twin-screw and motorships with the single-screw steamer, and the crew regulations. You have to have an additional crew for the twin-screw ship.

Mr. Metten: I think so. There is one thing to remember in making comparisons on the point of fuel. I think it well to remember that we can not base all of our comparisons on present conditions because a great many of us think that the cost of fuel will gradually increase from year to year so that we should look forward a little to the certainty of higher fuel costs.

Mr. Briggs: That makes a very material difference in the saving if there is an advance in the cost of fuel.

Mr. Metten: I think that is the general impression among the shipping people, that they will have to pay more and more for their fuel as years go on.

Mr. O'Connell: Fuel of any kind? Oil is about as low as it ever has been.

Small Repair Charges on Motorship

Mr. Edmonds: Did they bring out economies in repairs?

Mr. Metten: That can be taken from the experience of other operating companies, like the Asiatic companies that have operated motorships for long periods of years, 12 to 14 years, motorships altogether, and no steamers in the far eastern trade. They formerly were steamship operators, but after starting with the first motorship sold off the steamers and are now operating with the Diesel. Their experience over that period of time is that the average cost of motorships is less than the upkeep of the steamer. They did not say exactly how much.

Mr. Edmonds: I see that Mr. Conti in his circular had given the operation of the ships, and states that the repairs on an average oil burner are about 25 per cent of the ordinary repairs on steam vessels. This is a circular by Mr. Conti, who testified this morning.

Mr. Edmonds: I think Mr. Conti's statement will correspond with the admirals' statement because they work together. They said at one time to me that the *WILLIAM PENN* went 30,000 miles to 40,000 miles on \$300 worth of repair. That is marvelous, because it is costing \$8,000 to \$10,000 on every voyage of one of the President ships.

Mr. Briggs: In the operation of vessels operated by Diesel power, have you had occasion to see any of the vessels that have been in operation for some time?

Mr. Metten: We have our engineers inspect almost every one of the larger motorships that reach either New York or Philadelphia and make a general examination for our own information. That has been carried on for a period of from 6 to 7 years.

Mr. Briggs: In those studies that you have made, to what extent have repairs on motorships been less than on steam-powered vessels?

Boiler Upkeep Costs

Mr. Metten: The big element in cost and upkeep of steam vessels is boilers.

Mr. Briggs: Those are discarded in motor-driven vessels?

Mr. Metten: They are absent, but to make a fair comparison you ought to extend it over a sufficient period of time to take into account absolute certainty of boiler renewals.

Mr. Edmonds: In the WILLIAM PENN report I notice that in three voyages of 27,000 miles to the voyage, 82,000 miles in all, they spent \$122 repairs in the engine room and to the *Ethan Allen* at the same they spent \$3,501.

Mr. Briggs: What are the relative sizes of the crews with respect to the steam powered and the Diesel-driven engines of the same type and same size?

Mr. Metten: In the Hog Island A boat which we converted there are 6 less men in the engineer's force on the motorship than on the steamer, both single-screw ships.

Mr. Briggs: In the actual operation of the vessel you comply with all the requirements by proper manning and specified manning of the vessel?

Mr. Metten: Yes.

Mr. Briggs: In this vessel that you have converted, what was the relative speed after conversion as compared with the steam speed?

Mr. Metten: One-half a knot speed under the Diesel.

Statement of H. G. Smith, Vice President Bethlehem Shipbuilding Corporation, New York City.

Mr. Smith: Mr. Chairman and gentlemen, I am very much in favor of this resolution. It offers the most direct, immediate, and cheapest way of adding to the merchant marine a suitable number of ships in the shortest possible time. From the point of view of American commerce the conversion of these vessels with the resultant lower cost of operation will overcome one of the handicaps under which American shipbuilding labors to-day. As a shipbuilder I am enthusiastically interested in this proposition because it seems to me it is going to give us an opportunity to put into our shipyards contracts for work which are badly needed. At no time in the history of shipbuilding and my association with it even in the hard days before the war has there been such a scarcity of work as there is to-day, with almost no new construction coming along, and this one question of conversion offers in my mind not only the best, but, as I might say, the only immediate solution that I can see to a possibly considerable amount of work for our shipyards. Bethlehem has a Diesel engine of its own design of which it has built three. Bethlehem went into this work very thoroughly and exhaustively, with a view to producing an engine which we believe is now in first class

shape and started by an installation some three or four years ago in one of our own ships for the simple purpose of trying out the engine and finding every weak point and from the results obtained to build another engine, which has been built and has been running at Bethlehem for nearly a year.

The Bethlehem Engine

Mr. Briggs: Under what patent are those built?

Mr. Smith: Under our own patent. This engine at Bethlehem has run the equivalent of 60,000 miles at 11 knots or 10 knots and is now running continuously together with gas engines in furnishing electric power for the operation of the plant. It is running now 6 days a week, 24 hours a day. I am perfectly satisfied that if this fund is made available for conversion work as well as new construction that there are a considerable number of private owners who would undertake to convert ships, buying from the Shipping Board and putting in the Diesel engines.

Mr. Briggs: You heard Admiral Benson's suggestion this morning that they fixed a nominal price of \$5 a dead-weight ton for conversion of these vessels into Diesel type, under the approval of the board, and that it felt disposition could be made of a number of vessels by the board in that way in all probability.

Mr. Smith: I think so, because the price of converting those, the low cost of that vessel, would place such a vessel in the hands of the American owner cheaper than such a vessel could be purchased abroad, and it therefore gives him his capital investment lower than foreign ships, leaving only the handicaps of the tariff to contend with. It might be more but it gives him a distinct advantage and from several conferences I have had with owners the difference in tariff would probably have shown him a profit instead of a loss on a considerable number of operations during the past year.

Believes in Wholesale Conversions

Mr. McKeown: Which would be the less cost to the purchaser buying the ship by the dead-weight ton at the cheap price with agreement to convert it and do that himself or would it be better for the government to convert the ships under a contract of 10 at a time?

Mr. Smith: I am in favor of both, as I think the greatest number of these ships that can be converted at once is the best answer to the proposition.

Mr. McKeown: I am heartily in favor of the proposition of converting ships to the Diesel engine because I think it will improve them very materially and reduce the cost of transportation, that is, the cost to the operator of the transportation. If the Government converts the ship through expenditure of its money, through its own contract, and it would make 10 contracts for conversion, then it seems to me we ought to be able to get that done for less per ton than the owner who is only converting one ship.

Mr. Edmonds: That has already been testified to, that a contract for 10 ships would run 20 to 35 per cent less, in conversion.

Mr. McKeown: Why not let the Government convert them all under their contracts so that the private owner will get the benefit?

Mr. Edmonds: That is what would be the result. The Government converts and sells the ships to men who take a 60 per cent mortgage.

Mr. Briggs: I understand that this is exactly what would happen because the private owner would get the difference in the saving that the Government was obtaining.

Mr. Smith: No, sir; that is not my thought. I think it would be a great mistake to confine it to the Shipping Board alone.

Government or Private Loans

Mr. McKeown: What I have been trying to get at is this: Would not conditions of this kind arise that where a man bought privately he would be borrowing more money and would have more credit extended to him simply because he bought it and converted it himself than to buy from the Government direct.

Mr. Smith: I think that is easily controlled.

Mr. O'Connell: Carrying out Mr. McKeown's suggestion, would not the price to the individual who intended to convert the ship rather than by conversion by the Government be contingent upon whether or not at the time he wanted to make the conversion the Government had a contract for a large number of ships, and, if so, the individual would have to pay 35 to 50 per cent more than the Government would have to pay so that it might be advisable to confine this activity or authority to convert ships to the Government, which in every instance would get the benefit of this 35 per cent saving.

Mr. Smith: I can not figure any saving of 35 per cent. I say 15 per cent is probably it.

Mr. O'Connell: The statement has been made before this committee by some gentleman that the cost of a single ship converted might be as much as 35 per cent more than the cost where 8 or 10 will be converted by the Government at the same time. You disagree with that statement and make it 15 per cent?

Mr. Smith: I think that would be a very liberal saving.

Federal or Private Conversions

Mr. Briggs: Referring back on that question of the cost to the individual owner or operator of converting, I thought you stated that if the Government had the opportunity of converting a certain number of these ships that would enable builders to make a better price to the individual when he came to submit it.

Mr. Smith: That is right.

Mr. Briggs: My own idea is, that probably there is a great deal of individual preference in the minds of operators of vessels as to the best type of Diesel for the vessels.

Mr. Smith: That is right. The individual owner wishes to choose his own type of engine.

Mr. Briggs: It might be you could convert a greater number of Shipping Board vessels of a certain type more or less desirable to individuals for cargo than if they bought a vessel and converted it themselves.

Mr. Briggs: Did you give the figures that you estimated would be the cost of conversion?

Mr. Smith: I think around \$50 a ton.

Mr. Briggs: What is the difference in construction costs of steamers and Diesel machinery from your own experience per dead-weight ton for similar class of vessels of similar size?

Mr. Smith: Our estimate is like this for complete cost of ship and its machinery, that Diesel installation will run probably from 12

(Continued on page 211)

to 15 per cent more than steam installation. It is assuming that it is completely Dieselized with electric auxiliaries. If you refer to machinery alone, including auxiliaries, I should say that the cost of machinery installation would probably amount to 40 per cent greater.

Mr. Briggs: How much speed do you think would be gained by these vessels with the Diesel type engine rather than steam powered vessels? You have heard testimony in one or two conversions that they gained half a knot or a little more.

Mr. Smith: I think it is safe to say that you might expect half a knot in the majority of the conversions.

Mr. Briggs: With reference to the marketability of vessels, do you think a reasonable number of vessels could be marketed by the Shipping Board and sold to cover the cost of conversions at \$5 per ton if this process took place?

Mr. Smith: Yes, I do.

Statement of James Swan, Marine Engineering and Shipping Age, New York City.

Mr. Swan: I did not come here with the idea of testifying, but in view of some of the questions asked this morning I thought that possibly I had some knowledge which might throw some light on the subject and be of some benefit to you. In September and October I was in Great Britain and went there especially to examine one of two Diesel engines. While there I had the opportunity, which I took advantage of, of talking with the Registrar of Shipping and also with a number of men prominently engaged in shipping operations there. Lloyd's were very explicit in their views. They are very conservative and rarely do anything unless convinced that it is the time to do it. They told me they are now satisfied the Diesel engine has passed the experimental stage, that there were a number of types that could be put into a ship with the knowledge that it was altogether probable that satisfactory results could be obtained. They felt convinced that eventually—they were not prepared to say just when—they would become practically universal in the cargo trade.

Lloyd's for insurance purposes makes a periodical survey of ships to make sure they are in good condition. An ordinary steamer is surveyed under their rules every four years, a complete survey. Up to the present time they have had a rule that motorships must be surveyed every year, but they now have before their committee and undoubtedly will approve it an extension of that period to two years. If you had had experience with Lloyd's, it means a great access of confidence on their part in the operation of the Diesel engines, or for their official position. It was said that in Great Britain, in September, a good steam cargo vessel of 8,000 tons could be bought for between £9 and £10 per ton. It was said that a complete motorship, having Diesel and other electric auxiliaries—would cost between 14 and 15 pounds per ton.

The Leading Diesel Types

Mr. Davis: It has been stated here that there are about five standard types of Diesel combustion marine engines being manufactured in this country. Are they manufacturing the same types or some of the same types in England?

Mr. Swan: Yes; I think some types are being manufactured abroad, except one or two

types. The Bethlehem type, which they developed themselves, is a type similar to the engine built over there.

Mr. Davis: You do not think there is any superiority over the American engines in England?

Mr. Swan: No. I think we have here the latest development. When a man takes out a ship license for any of the engines of the ones we have had presented, that covers all the improvements coming along at a later date, and the company giving the license agreed to credit that license in full as of any development that may take place. As far as we know, the latest developments that have been made in England have been taken advantage of by the builders here.

Mr. Edmonds: Take the different types—the Burmeister-Wain is German.

(The B. & W. Diesel is a Danish engine.—Editor.)

Mr. Swan: Copenhagen.

Mr. Edmonds: And the Werkspoor.

Mr. Swan: Dutch engine.

Mr. Edmonds: The Doxford?

Mr. Swan: The Doxford is an English engine. I might say there is a very interesting situation on that particular engine, that when I saw the engine firm of Doxford, big ship owners were preparing to give up the construction of steam engines and put on their boiler ships these engines. That is their present experience.

A Little Confusion Here!

Mr. Swan: Three big types have been built in this country on foreign liners. Then there is the Sulzer engine, which is not manufactured in this country except for submarines.

Mr. Edmonds: That is one of the German engines, not used over here very much.

Mr. Swan: Except for submarines it is not used to a great extent in this country.

(The Sulzer engine is of Swiss design and is built under license at St. Louis, Mo.—Editor.)

Mr. Edmonds: The McIntosh and Seymour and the Bethlehem are American engine types used on ships.

Mr. Swan: Yes. There are one or two other engines that give promise of good service.

Mr. Edmonds: The Winton is a steamer engine.

Mr. Swan: That is a different type.

(The Winton is a Diesel engine built at Cleveland, Ohio.—Editor.)

Further Statement By J. Pew

Mr. Davis: Have Furness-Withy ever installed Diesel type tramps in their service?

Mr. Pew: They have some very successful Diesel boats, and have ordered eight more between nine and ten thousand ton regular cargo boats.

Mr. Davis: For tramp service?

Mr. Pew: For tramp service. They are going into it altogether.

Mr. Edmonds: You think, then, it would be very advisable for us to notify all these other foreign countries that we propose to stay put and go in the business?

Mr. Swan: I think so; yes, sir; surely. We have an unusual opportunity right at present to do something.

Mr. Edmonds: And get a little ahead of them?

The Market for Converted Ships

Mr. Pew: I just want to make this statement. You asked the question a while ago whether or not these vessels can be sold. We

have the *Challenger* finished now and had an offer to sell her for between 5 and 10 per cent over what she cost us, after paying the Government the entire cost. We did not take it. I believe you will have a market for these vessels when they are completed, because they will cut down the cost of operation.

I was also going to say, in my estimation, the cost of installation of Diesel equipped power throughout will be no more expensive than the cost of the installation of a steam equipment throughout, except the cost of the material, that is, the machines and the pumps and everything else. They are electrically driven and are more expensive than the old-fashioned steam drive at present; but the actual labor in putting in the Diesel motors is about the same.

Mr. Briggs: Mr. Pew, in constructing a vessel Diesel powered and one steam powered, what is the difference in cost, approximately?

Mr. Pew: I would say, offhand, probable \$15 a ton, due to the additional cost of the electrical equipment of the auxiliaries and the additional cost at the present time of the Diesel engines. But that will come down as they can be manufactured in quantities. On the *Challenger* we paid \$100,000, within a thousand dollars either way—I do not know the exact amount—for the electric equipment, that is, the pumps, etc. That is new; it is new work for the pump makers and for the electrical people. In my opinion it will cost probably 33 per cent more to tear out and put in Diesel than it would to tear out and put in new equipment of steam throughout.

Mr. Briggs: That is somewhere near the approximate increase that we were given by Mr. Conti, that it represented 40 per cent, he thought.

Congressmen Receive An Invitation

Mr. Pew: Yes. Next Thursday a week from now we expect to run the *Challenger* on her trial trip, and we would be very glad to have as guests the members of this committee, and if any member or all of the committee can come to see it, we would be glad to have them see it, because that is why we bought the vessel and are converting it, to show what it will do.

Mr. Free: Where will that be?

Mr. Pew: We will run from Chester down the river and spend the day and come back at night; we will probably be gone from 10 o'clock in the morning until 10 o'clock at night.

Mr. Briggs: Are you familiar with the construction of Diesel engines? I know you install them in your plant for building ships.

Mr. Pew: We are building the Doxford engine. We call that the Sun-Doxford. We own the patents; we simply use the same name they did. They got the patents from Germany and we got the patents from Germany; we own the patent rights in this country.

Mr. Briggs: I am not going to ask you whether any better engine can be built than you build, but I am going to ask you this—

The Chairman: Maybe he would like to have you ask him. [Laughter.]

Mr. Briggs: It might be that he would answer, and truthfully, there is nothing that could be better. But what I want to ascertain is the extent to which improvements have been made in advance of the last year or two, in the perfection of the Diesel engine. Have they been material or slight?

Mr. Pew: I am of the opinion there have been improvements in the last two years and there are going to be further improvements. In my opinion it will give excellent service and

there are half a dozen engines that will do it at the present time.

Mr. Briggs: Frankly, what I had in mind was whether any of you gentlemen, if authority of Congress is given for the conversion of these vessels and build new ones, would say that before the conversion took place or that new vessels would be built, the Diesel engine would be so improved that the engine you are installing would not be anything like as good as those to be obtained later?

Cost of Developing Sun-Doxford Engine

Mr. Pew: From my own experience, to answer your question, we have roughly put between two million and two million and a quarter million in three different boats to demonstrate the engine will work. We ourselves think the engine is all right.

Mr. Bland: If we wait until that engine is going to be perfected, we are not going to get anywhere, are we?

Mr. Pew: You will wait forever.

Mr. Edmonds: More than three years ago you started making the Diesel engine, Mr. Smith?

Mr. Smith: Yes, sir. We feel the engine has already passed the experimental stage.

Mr. Briggs: I want to know whether you think it has reached a stage where it is no longer in the experimental stage, but is a practical type—subject, of course to higher development?

Mr. Smith: Absolutely; I think there is no question about that.

Statement of Harwood Palmer, President of Marine News, New York, N. Y.:

Mr. Palmer: Now my business relationship brings me in touch daily with steamship owners; not only steamship owners as transportation people, but steamship owners among the commercial interests who are transporting their own products. I have yet to meet one man who is not in favor of changing even his present ships. It is a question of money.

Now the steamship companies have gone through this period of depression in trade and they have also gone through the period of having bought their property, some of it, at \$200 a ton and it has gone down to \$30 a ton. That is the financial position of many of the steamship companies. The steamship companies in the overseas trade are interested in this, for this reason, that they can get a Diesel ship by paying \$5 a ton and, we will say, \$50 a ton for Dieselization and reconversion and have a cheaper capital cost than their foreign competitor.

Yesterday afternoon I went around to see some steamship companies and two of them told me if this fund was made available two of them would take 10. That is the market. And a number of them at different times have said they would be interested in taking them.

Mr. Larsen: At what price was that?

Mr. Palmer: They figure \$5 a ton for the hulls and they figure they will cost \$50 a ton after they are converted.

Mr. Palmer: There are more than that who have said they would take two and three or four.

Statement of M. A. Neeland, President of the New York Shipbuilding Corporation:

Mr. Neeland: We have purchased two ships from the Shipping Board, the *Ashbee* and the *Jacksonville*, about 5,500-ton ships, and we are installing an improved type of the Werkspoor Diesel engine, a four-cycle engine—I

guess one of the oldest makes there is. I want to answer a question that you asked, because I feel I am thoroughly convinced about that. The Diesel engine is a way past the experimental stage, so far as the principle of it is concerned. There will always be modifications of it in the design.

There will be modification of the four-cycle and two-cycle engine; some builders will exploit the two-cycle and other builders will exploit the four-cycle; but both types of engines have now been in service long enough to thoroughly demonstrate their practicability and economy. We went into this after I made a trip to Europe.

Mr. Briggs: When was that?

Mr. Neeland: In 1920, and I visited the Harland & Wolff plant at Belfast. They have, I think, the largest Diesel engine factory in the world and employed 5,000 people in their plant on the Clyde, doing nothing but building Diesel engines. I am not talking about the shipyards at Belfast; I mean the Diesel engine factory at Glasgow.

Cost of British Motorships

Mr. Briggs: What is the cost, as you found it, for the construction over there of Diesel-powered ships per dead-weight ton?

Mr. Neeland: I think the most recent figures that I have heard were from 11 to 13 pounds per ton; I think those were the most recent figures I have heard.

Mr. Briggs: If you do not mind telling us, what was the cost of conversion?

Mr. Neeland: That I could not answer you, because we purchased two ships and we run the two engines through the shop together; we have got one installed on the ship and the other is in process of manufacture, and they are keeping the costs together.

Statement of T. O. Lisle, Editor, Motorship, New York, N. Y.

Mr. Lisle: Mr. Neeland just mentioned that a couple of years ago he was at Harland & Wolff's where they have a big plant employing 5,000 men. I was over there this fall and went over that plant and it was really a remarkable plant. I also went farther down the river to Scotstown and found an even bigger plant nearly completed. It was going to be opened a month later. I was also told by Harland & Wolff that they have opened up a big plant at Belfast, and they had the first set of engines completed and were going to build there high powered engines, up to 20,000 horsepower, for liners they have under construction at the present time.

What I want to say is; it is true that the cost of the complete engine-room machinery of the motorship is from 30% to 35% higher than a steamer. But the cost of a complete motorship is only 12% to 15% higher, as the machinery is only a part of the whole unit. If you take a vessel of the same dimensions with Diesels you increase her cargo capacity; say she is a 10,000 ton vessel, you increase her cargo capacity from 500 to 1,000 tons, according to the distance the vessel is going, and according to the class of cargo, whether it is cotton or ore. So that really you have a larger vessel, even if you pay more for it. And that is exactly what happens when you convert a ship. I believe on the "Seekonk" Cramps increased the cargo capacity nearly 1,000 tons.

Fund Available for Existing Private Ships

There is another point I think has not been brought out today; that is, that this amend-

ment, or resolution, if it passed, should enable the shipowners who in the past have bought ships from the Shipping Board and who have built ships on their own responsibility with steam engines, to be allowed to borrow money from this fund for the purpose of converting them to motorships.

Mr. Edmonds: That is in the amendment to the bill.

Mr. Lisle: For the conversion of existing private ships and not only Shipping Board ships?

Mr. Edmonds: For the conversion of any ships, and they can borrow money to convert their own.

(The following was submitted by Mr. Lisle:)

ADVANTAGES OF DIESEL-DRIVEN MOTORSHIPS COMPARED WITH OIL-FIRED AND COAL-BURNING STEAMERS

1. Ten per cent to twelve per cent gain in cargo capacity.
2. Very large reduction in fuel bill.
3. Equal constructional cost per ton of net cargo carried compared with steamer.
4. Absence of stand-by charges in port, and greatly reduced port fuel consumption.
5. Greatly increased cruising radius.
6. Less frequent bunkering, allowing fuel to be bought where oil is the cheapest.
7. Elimination of unruly firemen worries.
8. Reduced engine-room staff.
9. Revolutions of propellers are constant, and not dependent upon moods, and energies of stokers, changes of watch, etc.
10. Propellers do not race in heavy weather.
11. Better propulsive efficiency when ship is in ballast if ship has twin screws.
12. Better average speed over long periods, due to constant propeller speed.
13. Have about 30 per cent special emergency reserve power over normal compared with about 10 to 15 per cent with steam.
14. Smaller wage and food bills due to absence of firemen.
15. Engines always ready for instant start from cold.
16. Very rapid maneuvering—"full ahead" to "full astern" in 5 to 12 seconds.
17. Waste exhaust gases can be used for economically operating part of auxiliaries, including steering-gear, or for heating fuel-oil and for cooking.
18. Elimination of steam piping on deck.
19. Better conditions for engineers.
20. More rapid handling of cargo, effecting shorter stay in port.
21. Deep tank can always be used for dry or oil cargo, thus increasing earning powers on both long and short voyages.
22. Hulls can be made smaller, but still carry as much cargo as larger steamers, thus reducing first cost to equal that of steam.
23. Oil in double bottoms adds several years to life of ship, there also being no heat from boilers.
24. Depreciation can be spread over 20 years, due to not requiring reboiling after 10 years' service.
25. Low maintenance and repair charges.
26. Reliability now betters that of steam machinery.
27. Saving of tug charges in port due to rapid handling.
28. No cleaning grate, blowing tubes, ejecting ashes, or smoke nuisance.
29. Better average speed reduces cargo insurance charges.

(To be concluded next month)

REVIEWS OF RECENTLY ISSUED TECHNICAL BOOKS

Practically All These Works Can Be Obtained Through Motorship, 27 Pearl St., New York

The "Diesel and Oil Engine Hand Book" is a reference book intended for the use of operating mechanics. It contains general data on elementary engineering physics, and a miscellany of oil engine catalog material. Owing to the peculiar method according to which the book is divided into chapters and sections, its character as a hand book is somewhat obscured and it can hardly be referred to as a hand book in the sense of a systematic compilation. Subjects so diverse as compressors, cylinder design, and gear transmissions are not generally found associated together and it is questionable whether the treatment of them in one and the same chapter achieves any great advantage. Illustrations are numerous and sufficiently clear for the general purposes of the book. The statement of a few of the elements of engineering science is correct enough, but it is difficult to see how the unschooled mechanic could make anything out of it. There are half-tone illustrations of an indicator and a planimeter, but the vital subject of indicating and planimetry technique is entirely absent. As a collection of brief descriptions of current types of engines the "Diesel and Oil Engine Hand Book" possesses a certain amount of merit, although the omission of types so noteworthy as Busch-Sulzer and Worthington appears to be serious. The author is Julius Rosbloom and the publisher is The Technical Press Publishing Company.

* * *

A remarkably clear and straightforward work on what has always been a trying subject is Moyer, Calderwood, and Potter's "Elements of Engineering Thermodynamics." A good many authors of books dealing with mathematical subjects are so anxious to make sure of having their writings considered scientific that they sacrifice readability and ease of assimilation. To them making a demonstration rigorous means burdening it down with a mass of material calculated to close off every possible avenue for logical attack; what they actually succeed in doing is to envelop their kernel of information with a hard polished shell impenetrable alike to attack and understanding. "Engineering Thermodynamics" is in all respects a scientific work; but it says what it has to say in a commonsense manner. We were particularly pleased with the treatment of the skeleton-in-the-closet of thermodynamics, that ghostly quantity, entropy: "It has, therefore, been found desirable to make use of a diagram which shows directly by an area the number of heat units (instead of foot-pounds) involved during any process. In order that an area shall represent this value the coordinates must be such that their product will give heat units." As a work on general thermodynamics from which an oil engine man can quickly and directly draw every thing he needs, we cannot recommend "Engineering Thermodynamics" too highly. Published by John Wiley & Sons.

* * *

Friction is a thing with which all engineers and persons interested in engineering undertakings are bound to come in constant contact. It is one of the ironies of fate that so universal and commonplace an occurrence should at the same time be one which is so elusive and so difficult to reduce to scientific terms. Everyone is familiar with the simple laws of friction stated by Morin and taught in high-school physics classes and it is beyond the reach of large numbers of engineers to handle their friction problems by methods more advanced than these crude approximations. T. E. Stanton in his newly published treatise, "Friction," takes up this problem and deals with it in a masterly way. He re-classifies the various forms of fric-

tion in accordance with the results of modern researches and treats them with all the most advanced resources of mathematics and physics that modern science has to offer. Calculations of the utmost complexity are used, but it is apparent also that Mr. Stanton has carefully searched out every item of physical knowledge available to form a starting point and basis for his mathematical deductions. Published by Longmans, Green and Company.

* * *

As a prolific writer of magazine articles, Mr. L. H. Morrison is well-known to the oil-engine public. As is also apparent from his recently published book, "Diesel Engines," his study and observation of the subject has covered a considerable term of years and he has been systematic in accumulating a mass of information relating to American oil-engine practice. Mr. Morrison views his subject from the point of view of the operator and treats design questions only insofar as they have a direct bearing on operation. It is refreshing to find no allusions to thermodynamics anywhere in the book and almost everyone will appreciate an introductory chapter free from isodiabatic cycles and devoted instead to an interesting general survey. A chapter of considerable originality is the one entitled "Economic Status of the Diesel"; it gives a readable presentation of the kind of statistical material which is, after all, closest to the vital spot of all Diesel engine undertakings. A chapter entitled "Oil Engine Installation" is short, but bristles with tricks of the erecting man's trade. Lubrication and operation are given separate and very complete chapters; indicating, too, is fully treated, but there is nothing in this chapter suggesting anything about the fine points of indicating technique. The author's treatment of "Diesel Engines of the United States" is as full and complete as any which we have seen and is profusely and clearly illustrated. "Diesel Engines" is published by the McGraw-Hill Book Company.

* * *

The fourth edition of Dr. Bauer's well-known book on Marine Engineering "Berechnung und Konstruktion der Schiffsmaschinen und Kessel" (the English translation of the former editions is known under the names of Bauer and Robertson, published by Crosby Lockwood & Son, London), has been sold out some years ago and is now followed by an entirely new work of the same author "Der Schiffsmaschinenbau." This book, which is to comprise all branches of marine engineering, will be edited in several volumes, the first of which has recently appeared; the two others, which are to comprise the turbine drive and the propulsion by internal combustion engines, are to appear within the next 6 and 12 months respectively.

The first volume is, to a great extent, devoted to the reciprocating steam engine, but it deals also with a great many theoretical questions which are of great importance for the construction of all sorts of marine engines, as f. i. vibrations of shafts, transfer of heat, balancing of engine, etc. A great part of the book is occupied by a comprehensive treatise on the screw propeller, based on the most modern practical and theoretical researches on this difficult matter. For this reason everyone interested in the propulsion of ships by internal combustion engines may find useful information in this book.

It is published by "Verlagsbuchhandlung," R. Oldenbourg, and contains 752 pages and 793 illustrations.

* * *

The Internal Combustion Engine, by Harry R. Ricardo; D. Van Nostrand Company, publishers. For the writer of this book internal-combustion engines mean automotive engines and although he has apparently for the sake of completeness included references to, and illustrations of, heavy-oil engines and double-acting tandem gas engines, it is easy to see that his mind is not on this part of the subject. There can be no doubt that Mr. Ricardo



Real service is given by the 125 b.h.p. Atlas-Imperial oil-engine of the tug *Radus*

has an excellent scientific grasp of his particular phase and that if he had concentrated upon automotive internal-combustion machines he would have produced a work of unique value. Indeed, with but a slight change in title this work is warmly to be commended to specialists in this line. The author is apparently a connoisseur of indicator diagrams and includes reproductions of some fine specimens of optical indicating of gasoline engines in his work. The foregoing characterization applies with particular force to the first volume; in the second, which is sub-titled "High-Speed Engines," Mr. Ricardo completely shakes off the irksome heavy-oil engine and wraps himself up in his favorite subject. By far the most striking feature of the second volume is the description of the "crosshead type" of automotive gasoline engine. The line drawings shown indicate that this machine has reached a fairly advanced stage of development; the two chief points of importance about it appear to be that it is capable of burning inferior gasoline of a high boiling point and that it can be built in stroke-and-bore sizes far beyond the rigid limits in this regard which are placed upon gasoline engines of the conventional type.

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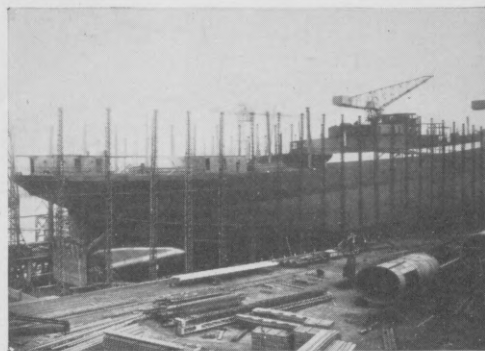
The fifteenth edition of Green's Marine Directory of the Great Lakes shows the same neatness and thoroughness with which this very useful book of reference has been gotten up in past years. To those who have not yet taken advantage of the many excellent features of this work it may be of interest to learn what a few of them are:

- Alphabetical List of Vessels
- Alphabetical List of Owners and Managers
- Alphabetical List of Passenger Boats
- Alphabetical List of Car Ferries
- Engines and Boilers of Lake Ships
- General Statistics of Lake Vessels.

These lists are very complete and to those who have business dealings of any kind with Great Lakes shipping enterprises, they speak for themselves. The directory is published by the Green Marine Directory of the Great Lakes Co.

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Brassey's Naval and Shipping Annual for 1924 (Wm. Clowes & Sons, Ltd.) may well be called the encyclopedia of British maritime affairs. It presents a detailed study of the activi-



Motorship *Camranh* of the Chargeurs Reunis Line, just before launching. Twin 1,750 shaft h.p. Sulzer Diesel engines are installed

ties of the British Royal Navy, describes new construction contemplated, and gives an account of the newest technical advances that have been made in the art of conducting warfare at sea. Remarkable progress in the building of aeroplane carrying ships is recorded and the illustrations of this latest type of fighting unit are most impressive. Not only the British, but also the navies of the major foreign powers are treated. All of this leads up to a remarkably succinct chapter entitled "Comparative Naval Strengths," authoritative information which it would be difficult and laborious for the general reader to obtain from any other source. "The World's Mercantile Marine" is a chapter full of pertinent information and condensed tables, the study of which should enable almost anyone to become well-posted in regard to this important and widely-ramified subject. Particular interest attaches to the chapter which deals with general marine-engineering problems of today and although this too is excellent, we could not help remarking as peculiar a paragraph in which the substitution of reciprocating steam-engines for geared turbines is alluded to. It seemed to display the "I told you so" attitude which to us is strangely out of keeping with the highly favorable comment on oil-engine development that is to be found elsewhere in the same chapter. The section entitled "The Diesel Oil Engine," although greatly condensed and maintaining an attitude of scientific impartiality, leaves absolutely no doubt in the mind of the reader that the last stronghold of marine conservatism has made an unconditional surrender before the triumphant progress of the modern heavy-oil engine.

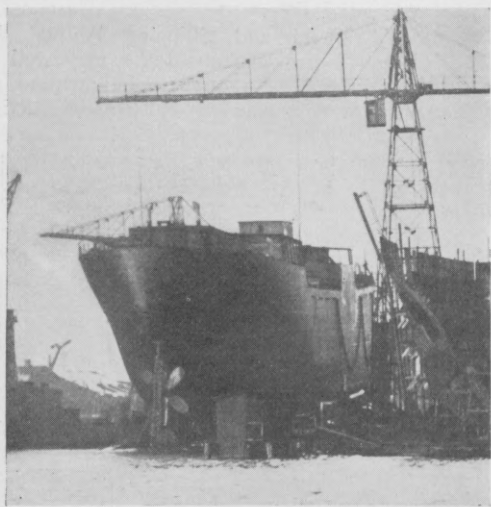
* * *

We have just received a small pamphlet from N. W. Akimoff entitled "The Working of the Marine Propeller." Basing his work on the researches of Prof. N. Y. Joukowsky and a number of German physicists and engineers, Mr. Akimoff develops an application of the vortex theory to screw propeller design. According to this it becomes necessary to give the propeller blades a variable pitch, which is a minimum towards the middle of the blade and increases as the tip and the hub are approached. Mr. Akimoff gives examples of screws actually built according to these lines and shows favorably efficiency curves describing their characteristics. An improvement of something like 5 per cent by comparison with propellers designed according to the best accepted methods is claimed.

* * *

The American Bureau of Shipping has presented *MOTORSHIP* with an inscribed copy of the "Record" for 1923; we are indebted, also, to the Department of Commerce for their Fifty-first Annual List of Merchant Vessels of the United States.

* * *



The motor tanker *Zoroaster* on the ways at Götaviken shipyard just prior to her launch. The new Nobel two-cycle Diesel engine is installed

As a sorry hodge-podge of misinformation we have not yet seen anything to equal the "Blue Book of Diesel and Internal Combustion Engines," written by E. R. Glass and published by the Ocean Publishing Co., 25 West 42nd St., New York City. Here are some gems, culled at random:

"Q. If one of the cylinders were not working properly, how would you find them?"

"A. I would open the valve on top of the cylinder, the one that is not working properly will discharge white smoke, the others will discharge a clear blaze.

"Q. What is a spray line?"

"A. A spray line is a copper fuel-tube running fore and aft across the top of the cylinder with branch tubes running from it to the fuel valve and atomizer in each cylinder head."

Although written primarily for the use of engineers preparing to apply for motor-vessel licenses, it would be manifestly possible for anyone to pass even this easy and perfunctory test on the basis of what is offered in the "Blue Book."

There is a crying need for a book of this sort written by someone who is equipped with sound engineering knowledge and who can also think and write in the same terms of thought as the operating engineers who would use it. It need in no sense be "written down to the level" of these men, because anyone who has been able to hold his own in the operating mill, be it steam or Diesel, has a good store of information tucked away somewhere in his cranium. This knowledge in many cases is entirely inarticulate, but it is there and can surely be touched by the writer who is equipped both in an engineering and a literary way to do it. We shall not carry Mr. Glass's book on our regular list, so we have not given the publishers' name and address.

* * *

The transactions of the Institute of Marine Engineers for December, 1923, contain an article of unusual interest for marine oil engine men entitled "Reversing Systems for Large Marine Oil Engines," by Miss V. Holmes, B. Sc. All the important reverse gears now generally found in service are readably and clearly described by text and illustrations, so that the reader is required to make little mental effort for grasping even the most complex of the systems treated. It would not be easy to refer anyone who wanted to know, say, how the Sulzer reverse operates, to anything currently published in the engineering press that would answer better than Miss Holmes' account. Remarkably clear and neat perspective drawings, particularly of the Burmeister & Wain system, are shown; and although these illustrations contain no more than what is just exactly necessary and not superfluous for quick understanding, they show a degree of painstaking care in their execution that is strongly reminiscent of a fine piece of embroidery. But Miss Holmes does not confine herself entirely to description and her comments and criticism are very much to the point. Mention is made in the discussion of the Women's Engineering Society. Surely if this newly-formed body is going to tackle all the branches of engineering with the same deftness displayed by Miss Holmes in her "Reversing Systems," the time has come when the masculine members of the profession will have to look to their laurels.

* * *

Before us is a copy of the Marine Number of the Bessemer Monthly for January 1924, published by the Bessemer Gas Engine Co., of Grove City, Pa. This issue of the magazine deals in a very interesting way with a number of marine installations of Atlas Diesel engines, the construction of which has been taken up by the Bessemer Company. A copy of this magazine will be sent to any reader of *MOTORSHIP* communicating with O. D. Treiber, Marine Dept., Bessemer Gas Engine Co., at Grove City, Pa.

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